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ABSTRACT

Learning behavior of young children of contrasting socioeconomic backgrounds is examined in this study, which poses the question: what are the necessary or sufficient environmental conditions for the establishment of identifiable patterns of behavior? Socioeconomic level (SEL), the principal independent variable, was defined in terms of parental occupation, income and education. Three sets of experiments were conducted, with varying age groups from high- and low-SEL schools and preschool programs. The first set employed concept formation procedures, the second investigated reward preferences, and the final set considered degree of stimulus control, as a function of SEL and as an interaction between SEL and training. Results are presented in detail. It is noted that differences between behavior of high- and low-SEL subjects were not always instances of high-SEL children doing "better" than the low-SEL group. Another study, included in this volume, investigated the distribution of changes in performance of high- and low-SEL subjects on a standardized achievement test. Subjects were 2nd-, 4th- and 6th-grade children, tested in the fall and spring and again the following fall. Results showed that the discrepancy between performances of high- and low-SEL children continuously increases with grade level. It was also found that a "tailing-off" tendency in improvement rates from spring to fall is more pronounced for low-SEL children, indicating a need for summer school programs. (BF)

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Professor of Psychology, Principal Investigator

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Acknowledgements

First we acknowledge our great appreciation to the Cobb County School System for their cooperation. No doubt the use of their pupils as subjects caused them considerable inconveneince. Mrs. Emily Cochran usually acted as our liason and displayed great patience with our more than occasional mismanagement; to Mrs. Cochran we are deeply grateful. We also appreciate the kind cooperation which the many nursery schools around Atlanta, Georgia, extended to our students.

The nine experiments are not ours alone. Our students did most of the hard work and we can only hope that they were compensated with some small amount of knowledge we may have passed on to them. Sandra Ivey was responsible for Experiment II and William Blum for Experiment III. Stephan Silverman conducted Experiment VI and Jo Mary Hilliard Experiment VII. Anthony Epworth designed and ran Experiments VIII and IX. The indebtedness of faculty to students is too widely understood to require belaboring. One's dependence upon his secretary is just as obvious. Brenda Jackson kept us on the track and smoothed our way in the outside world.

A very special acknowledgement is due our colleague, I. J. Knopf. The three of us started this research together. In time, Jay Knopf developed his own interests and techniques for studying vigilance as a function of age and socioeconomic level. We never diverged in our conceptions of the problems and never ceased consulting with each other. We think his investigations of vigilance have been well done; we hope he finds our work to be of some value.

J. L. Bresnahan

M. M. Shapiro

Learning Strategies in Children from Different Socioeconomic Levels

Jean L. Bresnahan and Martin M. Shapiro

Emory University

There has been much interest in the characteristics of children from different socioeconomic backgrounds. Many writers have described in detail the differences in the environments of children who come from the extremes of the socioeconomic dimensions in our society referred to here as high and low socioeconomic level (SEL).[1] Comprehensive reviews of the topic can be found in a 1965 issue of the Review of Educational Research and in Education in Depressed Areas edited by Passov in 1963.

The low SEL homes are typically depicted as overcrowded, noisy, and disorderly, and lacking in many of the items associated with the development of learning skills, such as books, magazines, records, and educational toys (e.g., Gordon, 1965). Many of the authors emphasize the nature of the children's interactions with their parents, and consider this variable to be even more crucial than the material aspects of the homes. In particular, much attention has been devoted to the differences in the verbal communication in high and low SEL homes, and the consequent language development of the children (McCarthy, 1954; Bernstein, 1961; Raph, 1965; Hess & Shipman, 1965). The general findings have been that low SEL parents speak to their children in short simple sentences, usually commands, but rarely use language to elaborate or explain concepts.

The differences in the behavior of high and low SEL children have likewise been observed and reported. It is well documented that low SEL children perform less successfully than high SEL children in many diverse kinds of experimental, academic, and vocational situations (e.g., Karp & Sigel, 1965).

They are considered deficient in reading, number concepts, time concepts, auditory discrimination, visual discrimination, and symbolic representation (e.g., Duetsch, 1963; Montague, 1964; Riessman, 1964). Their intellectual functioning has been described as more concrete and inflexible than more privileged children (McCandless, 1952). They are depicted as being restless and prone to physical activity, and having a short attention span. They are said to be motivated only by short term goals, incapable of postponing immediate gratifications, nonresponsive to symbolic or verbal incentives, and lacking in aspirations consistent with middle-class values (e.g., Gordon, 1965).

These descriptions of environmental and behavioral differences among SELs have been voluminous and encyclopedic. Attempts have been made to quantify the observations and obtain correlations among several categories of variables. Unfortunately such work suffers from the limitations of all similar endeavors; it is exceedingly difficult if not impossible to separate phenomena from epiphenomena, relationships from artifacts. The question still remains, "What are the necessary or sufficient environmental conditions for the establishment of identifiable patterns of behavior?" Fortunately the available correlational data do provide the bases for intuitions and guesses. We chose to begin with SEL as the principal independent variable knowing full well that the ultimate goal was to replace that vague and confounded construct by a set of scientifically more manageable variables.

Variables

SEL was defined for our purposes in terms of the occupation, income, and education of the parents. This gross and impure subject variables, SEL, was combined with manipulations of the more clearly definable independent variables of reinforcement schedule and reinforcement contingency.[1] Using the information obtained in the first few studies we then employed multiphase

experimental procedures which manipulated pretraining conditions. In the process SEL became less and less interesting, and the pretraining became more and more interesting. Instead of assuming that SEL was correlated with childhood training, we manipulated the pretraining.

A similar evolution occurred in the choice of dependent variables. We began by presenting the subject with two stimuli and asking him to choose one of them in a concept acquisition task; later we asked subjects to choose between two reinforcement schedules. We then measured rates of responding to several different stimuli. Additionally, we analyzed the sequence of choices between two stimuli or between two responses.

Outline of Experiments

The first set of experiments to be presented employed concept formation procedures. High and low SEL children were trained to select one of two stimuli either on the basis of size or on the basis of number. Each child was trained with one of three reinforcing events. An attempt was made to investigate attention through the use of a transfer design. The discrepancy between the results on the size and number tasks was subsequently viewed and investigated as a difference between obviousness of stimulus dimensions. A pretraining procedure was then introduced into the design to determine the conditions under which the performance of high and low SEL subjects would be equalized. Following this study, subjects from an undefined SEL sampled from middle range schools were studied to test the hypotheses generated with respect to the acquisition of strategies during concept formation.

The second set of experiments investigated reward preferences in children from high and low SELs. The subjects were allowed to choose between two keys, one of which resulted in a fixed reinforcement schedule and one of which re-

sulted in a variable reinforcement schedule. To further investigate the differences found in the behavior of the two SEL groups, an experiment was designed to study the effect of the magnitude of the previous reinforcement and the effect of a signal predicting the magnitude of the next reinforcement.

The final set of experiments considered the degree of stimulus control, first as a function of SEL and second as an interaction between SEL and training. A related pair of studies investigated the behavior control of instructed and trained stimuli, first as a function of age and second as a function of pretraining.

Concept Formation

The Board of Education provided the names of schools which had children from either the highest or the lowest SELs in the county. The principals of the schools provided access to the cumulative records of the students. From these records the following information was obtained: name, address, date of birth, occupation of parents, education of parents. All repeaters were eliminated.

In Experiment I the following indices were used to determine SEL: location and quality of residence, occupation of parents, education of parents, grooming of the child. For the residence requirement only houses in very good condition and not too small in size qualified for the high SEL group. The houses in the low SEL group were quite deteriorated and in need of repair and were often very small in size. The houses for the high SEL and low SEL groups corresponded to Warner, Meeker, and Eells' (1949) house types 1 and 2, and 6 and 7 respectively. Similarly the occupations of the high SEL and low SEL groups corresponded roughly to Warner, Meeker, and Eells' classes 1 and 2, and 6 and 7 respectively. In the former were professionals, semi-professionals, and proprietors of large bussinesses; in the latter were craftsmen, semi-skilled workers, and unskilled workers. In the high SEL group most fathers were college graduates. In the low SEL group most parents had a seventh to tenth

grade education. The schools chosen were either predominantly high or low in SEL, and subjects from any one school were included in only one of the SEL groups, not both. That is, deviant children in these schools were not considered for the opposite group, e.g., a physician's daughter in a low SEL school would not have been placed in the high SEL group. Since we were most interested in SEL as a possible index of early training, the groomed appearance of the child was rated on a five point scale. To be included in this study a rating of 1 - 3 was required for the low SEL group and a rating of 3 - 5 was required for the high SEL group. A measure of grooming proved to be cumbersome and of dubious value. In subsequent studies the criteria of grooming and quality of residence were not considered

In Experiment I the possibility was considered that the discrepancy in the performance of the two SEL groups would be reduced if reinforcers and tasks appropriate to the low SEL group were utilized. An even stronger prediction was that under some conditions there would be no difference in performance or that the low SEL children might surpass the high SEL children. To investigate the kinds of situations which produce equal or differential success between high and low SEL groups, therefore, an experiment was designed in which the kinds of tasks and incentive were manipulated. All other factors such as the stimuli and apparatus were chosen or designed with the intent of maximizing performance for the low SEL children.

The experimental task was one of concept acquisition (used interchangeably in this context with concept formation, concept attainment, concept utilization, concept identification). Because "concept" is a word psychology has borrowed from the vernacular, there is no consistant use of the term in the research literature. In this experiment the number of stimuli exceeded the number of

possible responses and concept formation was simply meant to imply the acquisition of common responses to dissimilar stimuli.

It was necessary to choose stimuli with which all children are familiar. Items that are assumed to be universally known include the common varieties of food, household objects, and clothing. Buttons were chosen for several reasons. It was possible to use actual ones as stimuli; for large objects it would have been necessary to resort to either small facsimilies or printed reproductions, either of which would most likely have placed high SEL children at an advantage. Similarly, the fact that the subjects would be able to actually touch and handle the stimuli was a desirable feature; two dimentional slides or cards might also have been more advantageous for high SEL children. Buttons, of course, were convenient as stimuli since they vary in so many dimensions.

For the experimental task itself, the buttons allowed the testing of a concept which all children learn by themselves at a very early age. Moreover, they also were appropriate for a concept which is more dependent on specific teaching by others, or at least more related to previous training. These concepts were, respectively, size and number. For both size and number a relationship concept was used. The size and number tasks differed in difficulty in another important aspect which is related to the functional-conceptual classification. From infancy, size is a relevant and pervasive dimension for all children. It is a variable which they encounter in countless ways. Even more specifically, the attribute of "bigness" itself comes to have positive value for them. In the case of buttons, size can be considered the most obvious and most functional dimension. It was expected, therefore, that the task of choosing the larger of two different size buttons would be extremely easy. Choosing the button with the greater number of holes, however,

has very little relevance to experience in an actual environment. The utility of number of holes with respect to the usual function of buttons is trivial. When contrasted with the dimensions of size and color, the number of holes is a rather obscure dimension.

It seemed desirable to include incentive conditions which were expected to result in different levels of performance. These conditions were: knowledge of results only, knowledge of results plus social reinforcemnt, knowledge of results plus social reinforcement plus a tangible reward. All testing was done in the school. Ninety-eight first-grade girls were used in this first study. The subject was brought by the experimenter from her classroom into the experimental room. She was seated directly in front of a table on which rested two plywood panels. For all three reinforcement conditions one of the panels was the same. For the mechanical reinforcement condition, a large second panel was attached to the first. For the social and tangible reinforcement conditions, a much smaller second panel was attached to the first. Figure 1 shows the experimental apparatus for the mechanical reinforcement

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condition. All panels were painted with diagonal red and white stripes. Two cartoon faces were inserted in the first panel; the top face was a smiling one, the bottom face, a sad one with tears. A royal blue plywood tray rested on the table within the opening at the bottom of the first panel. A lid on the tray allowed it to be completely covered or opened, with the subject not being able to see the experimenter when the lid was in either position. Each of the second panels had a dark green chute. The buttons were presented in the royal blue tray and the subject responded by picking up one of them and

Figure 1. Apparatus panels for mechanical reinforcement condition. The subject has taken a button from the blue tray and is putting it into the green chute. If the button is the correct one the happy face will light up and a bell will sound. If the button is the incorrect one the sad face will light up and a buzzer will sound; the subject will then pick up the other button in the blue tray and place it in the green chute, resulting in the happy face and bell.

dropping it into the dark green chute. All events were programmed electronically. For the mechanical reinforcement condition the experimenter merely served as the transducer, translating the subject's response to an electrical impulse by pressing a push button switch. An easily discriminable bell and buzzer of the usual 6-volt household variety were mounted on the rear of the apparatus panel. The Peabody Picture Vocabulary Test was administered when the subject was brought from her first grade classroom into the experimental room. This test required approximately 10 minutes. Following the completion of the intelligence test, the subject was told that she was going to play a game. She was told that two things would be dropped into the blue tray and that one of them was right and the other was wrong. She was asked to pick up the one she thought was right and put it into the green chute. The procedure was demonstrated to the subject as well as the consequences for a right and wrong response. If the right response was made, the happy face lit up and the bell was sounded. If the wrong response was made, the sad face lit up and the buzzer was sounded. To make certain that there was no ambiguity for the subject as to which stimulus was correct on any trial, a correction procedure was used. The subject was instructed to make the correct response on those trials in which the original response was incorrect. All demonstrations were done with practice stimuli distinct from those used in the actual experiment.

Within each SEL group there were three reinforcement conditions (mechanical, social, tangible) and two tasks (size, number) for a total of twelve independent groups. In the mechanical reinforcement condition the larger second panel was used and the experimenter sat behind the panel completely concealed from the subject. After each trial the only feedback the subject

received for the response were the lighted face and bell (or buzzer). In the social reinforcement condition the smaller second panel was used. The subject could see the experimenter and after a correct response, the happy face and bell were accompanied by generous verbal support, such as "Good," "Very good," "Fine," "You've been getting them all right," etc. After a wrong response, in addition to the sad face and the buzzer, the experimenter commented, "That one was wrong," "You picked the wrong one," etc. On a correction response, the experimenter said, "Okay," "All right," "Yes, that was the right one," etc. In the tangible reinforcement condition the small second panel was again used and in addition to the verbal support, the subject was given a penny for every correct response (pennies were not given for correction responses). Whenever the subject's original response was correct, the experimenter put a shiny new penny into a glass dish in front of the subject. Extraneous conversation between the experimenter and the subject was minimized in all conditions. All trials were paced by the subject since as soon as she responded, the experimenter pressed the "right" or "wrong" push button, and if it were the former, the experimenter then immediately presented the next two stimuli.

All subjects received 60 acquisition trials on each of which two buttons were presented in the tray. The experimenter tossed the buttons into the tray to make it apparent to the subject that location of the stimuli in the tray was not a variable. Before each trial began, the lid on the tray was closed, but it was raised as soon as the buttons were tossed into the tray. Immediately after the correct button was placed in the chute the lid was again closed. One-half of the subjects from each reinforcement condition had the size task; the other half of the subjects had the number task. On both tasks,

the buttons differed in color, size, and number of holes. There were four colors, four sizes, and four "numbers of holes." For both the size and number tasks, color was an irrelevant dimension.

For the size task, the correct button was always the larger of the two. Of the twelve pairs of buttons which were repeated five times, six of them were correlated positively with number of holes, i.e., the larger button was also the button with more holes. For the remaining six pairs, the larger and smaller buttons had the same number of holes. For no pairs, therefore, were size and number of holes negatively correlated. For the number task, the correct button was always the one with the greater number of holes. Just as in the size task, for six pairs the number of holes was positively correlated with size, and for the remaining six pairs the buttons were of the same size. After trial 60, each subject was asked to guess the button which was right without the light, bell, or buzzer (and pennies when appropriate) being presented. Two buttons were then presented in the usual manner and after the subject had dropped one in the chute, the experimenter removed the remaining button from the tray and in its place immediately presented the next pair, without giving any feedback to the subject. For this transfer task, there were ten trials. Five pairs of buttons were presented twice in the same order. These buttons likewise differed in color, size, and number of holes, but the colors were different from those of the acquisition trials. For the transfer trials after the size problem, both buttons of the pair were the same color and equal in size but differed in number of holes. For the transfer trials after the number problem, both buttons of a pair were the same color and had an equal number of holes, but differed in size. This transfer task could be viewed as an incidental learning problem. The transfer test was designed to determine

whether there was differential attending or selective responding to the stimuli by the two SEL groups.

A control group of seven subjects from each SEL was run under the mechanical reinforcement condition on the size task. The procedure was identical to that used for the experimental group with the exception of changes in stimuli on three correlated trials. The set of buttons for the control group, therefore, contained three pairs of buttons on which size and number of holes were positively correlated, six pairs for which these variables were uncorrelated, and three pairs for which these variables were negatively correlated. The transfer trials remained the same for the control group.

The results from this first experiment were most encouraging. The first useful finding was that we could ignore IQ as a variable. The mean IQ for the high SEL group was 103.52 with a standard deviation of 11.93, and the mean IQ for the low SEL group was 88.84 with a standard deviation of 14.51. This difference was shown to be significant, $t(82) = 5.008$, $p < .01$. Correlations and partial correlations between IQ and the dependent variables yielded insignificant results in all cases. Therefore, it was concluded that although the two SEL groups differed significantly in IQ, IQ was not related to the performance of the subjects on the concept formation task.

The 60 acquisition trials were divided into ten blocks of six trials each. The acquisition curves for each of the twelve experimental groups are plotted in Figure 2. The results of analysis of variance are shown in Table 1.

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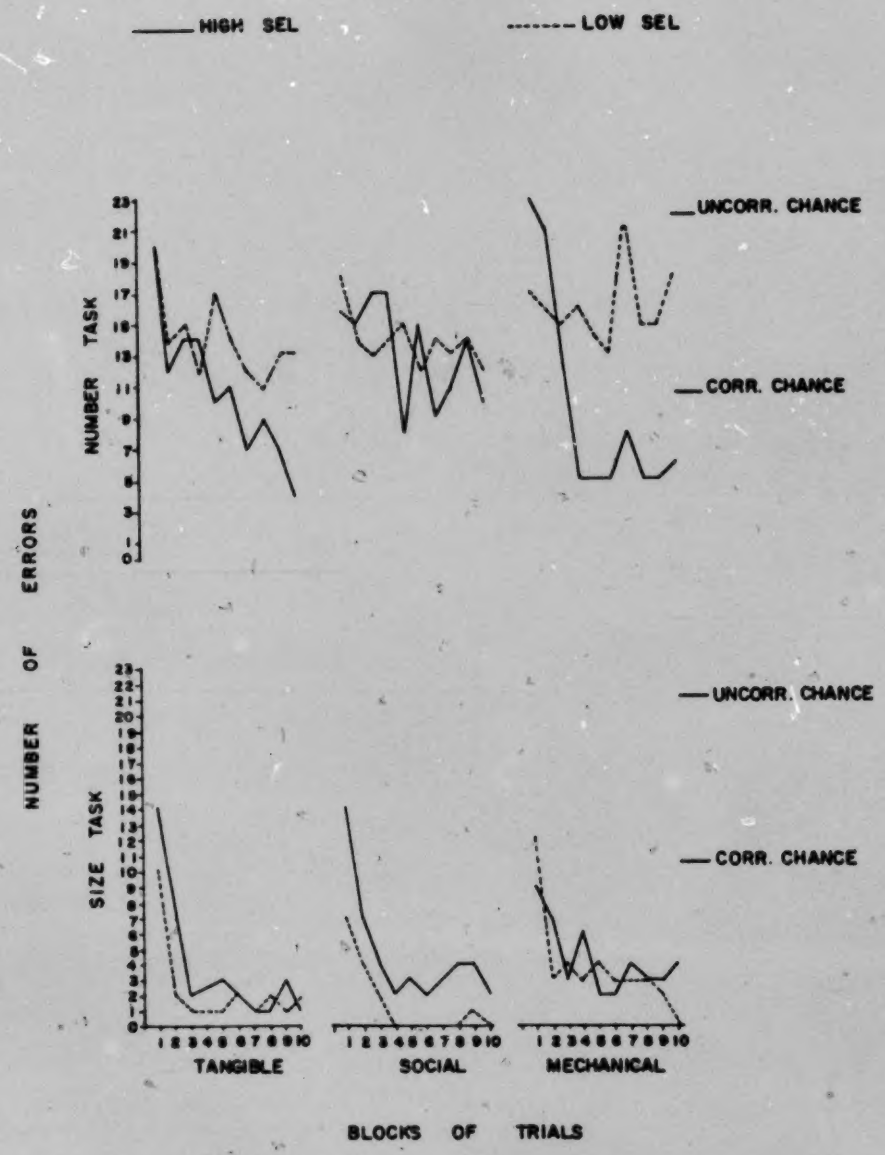

Figure 2. Number of errors in blocks of six acquisition trials for 12 experimental groups specified by SEL, reinforcement, and task. Correlated and uncorrelated chance levels of performance are marked on the right-hand side of the figure.

TABLE 1

Analysis of variance for 60 acquisition trials with number of errors in blocks of six trials as the dependent variable.

Source of variance	df	SS	MS	F	Prob.
Between subjects	83	1031.424			
E(SEL)	1	4.005	4.005		
R(Reinforcement)	2	1.688	0.845		
P(Task)	1	400.478	400.478	49.738	<.01
E x R	2	11.731	5.865		
E x P	1	28.971	28.971	3.598	>.05
R x P	2	2.745	1.373		
E x R x P	2	1.979	0.989		
S_wG(Subjects within groups)	72	579.829	8.052		
Within subjects	756	677.200			
t(trials)	9	107.695	11.966	16.034	<.01
E x t	9	17.686	1.965	2.633	<.01
R x t	18	13.169	0.776		
P x t	9	3.929	0.437		
E x R x t	18	7.793	0.433		
E x P x t	9	10.148	1.128	1.511	
R x P x t	18	16.636	0.924		
E x R x P x t	18	16.545	0.919		
S_wG x t	648	483.600	0.746		
Total	839	1708.624			

Size was significantly easier than number as a task; the acquisition curves for the two tasks are plotted in Figure 3. There was no significant SEL ef-

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fect. There was an inversion of errors on size and number tasks for the two SEL groups, reflected by the .06 probability of the interaction between SEL and Task. There was a significant Trials effect and a significant interaction between SEL and Trials. This interaction is shown in Figure 4, where in the

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first two blocks of trials the errors for the high SEL exceed those for the low SEL, but the curves reverse and diverge in later blocks of trials. The low SEL curve reaches asymptote quite early and remains elevated. Since the results of an analysis of variance are at best relatively unspecific, we should now direct our attention to a more detailed analysis of errors on correlated and uncorrelated trials. It was considered possible that the SEL by Trial interaction and the SEL by Task inversion resulted from different strategies used by the two SEL groups. Since the low SEL group performed better on the size problem, the question arose as to whether the low SEL group was using size differences in their attempt to solve the number problem. In view of the fact that size was positively correlated with number on one-half of the pairs and uncorrelated with number on the other half, responding according to size would have produced approximately 75% correct, whereas guessing would have produced approximately 50% correct. As seen in Figure 2, the low SEL size curves show fast acquisition while the low SEL number curves show very little acquisition. The latter never exceed a level superior to that which would

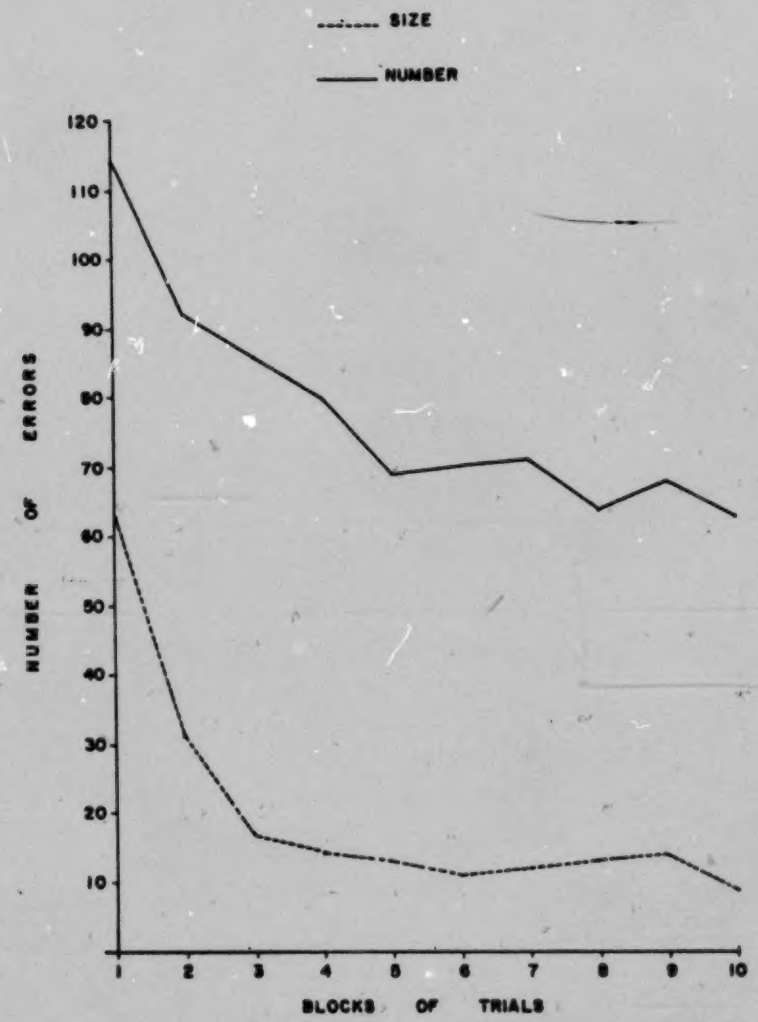

Figure 3. Curves for number of errors in size and number tasks plotted in blocks of six acquisition trials.

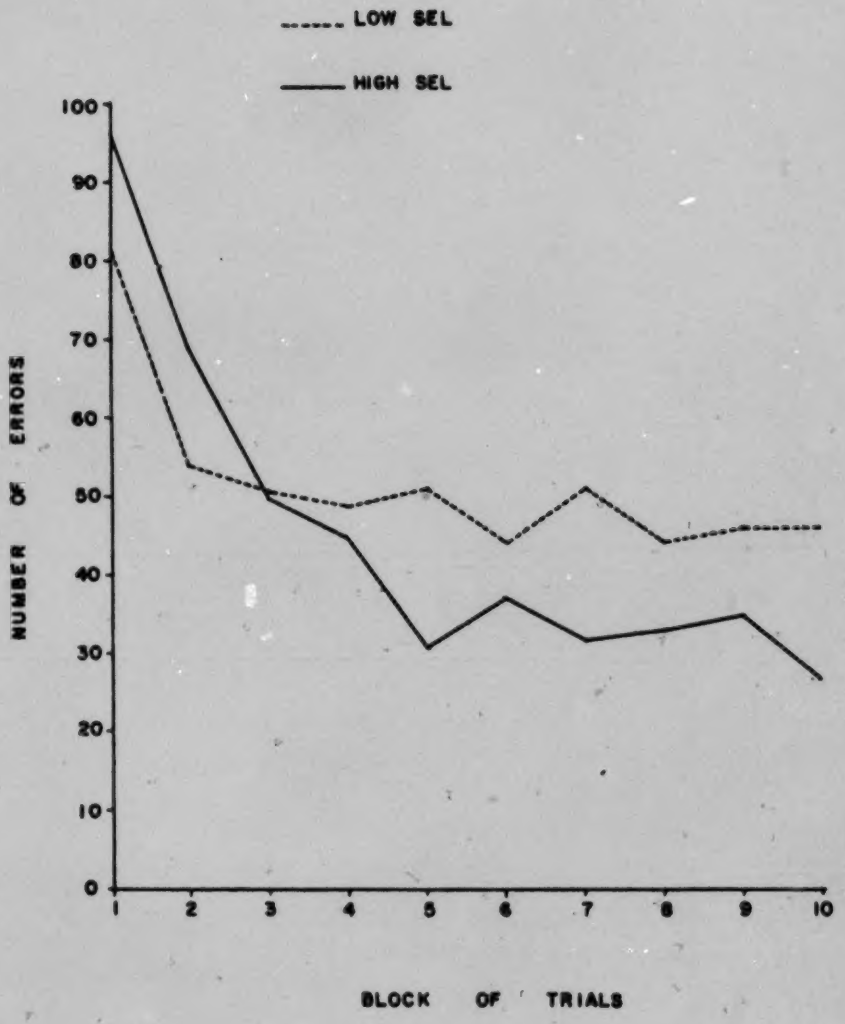

Figure 4. Curves for number of errors in high and low SEL groups plotted in blocks of six acquisition trials.

have been attained had the stimuli been chosen on the basis of size (correlated chance). They remain at a level between correlated chance and random selection of the stimuli (uncorrelated chance). The errors for the correlated and uncorrelated trials for the first two blocks of trials are shown in Figure 5. On the abscissa the numbers 1, 4, 5, 7, 9, and 11 represent correlated

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trials and the numbers 2, 3, 6, 8, 10, and 12, uncorrelated trials. As expected, only the number problem for the low SEL (Figure 5d) group shows the uncorrelated trials to be more difficult. The hypothesis is supported that the high SEL subjects do not select the stimulus on the basis of the partially reinforced dimension as seen in Figures 5a and 5b. For the size problem the low SEL subjects selected the larger stimulus which was the correct stimulus, thus yielding no difference in the curves for Figure 5c. These relationships hold even when the twelve groups are further subdivided by reinforcement condition and the N is thereby reduced by one-third. There is no overlap whatsoever in the number of errors on correlated and uncorrelated trials for the low SEL subjects trained on the number task.

To determine whether there was any natural bias in the selection of the buttons, the number of errors prior to each subject's first correct response was calculated. If no biase was present, the expectation was a geometric distribution ($p = .5$) for the number of errors to the first correct response. Neither the observed frequencies of the total group nor the subgroups differed significantly from the expected frequencies. In fact, the fit was amazingly good. The analysis of number of errors to the first correct response does not contradict the results of the previous paragraph on the correlated and uncorre-

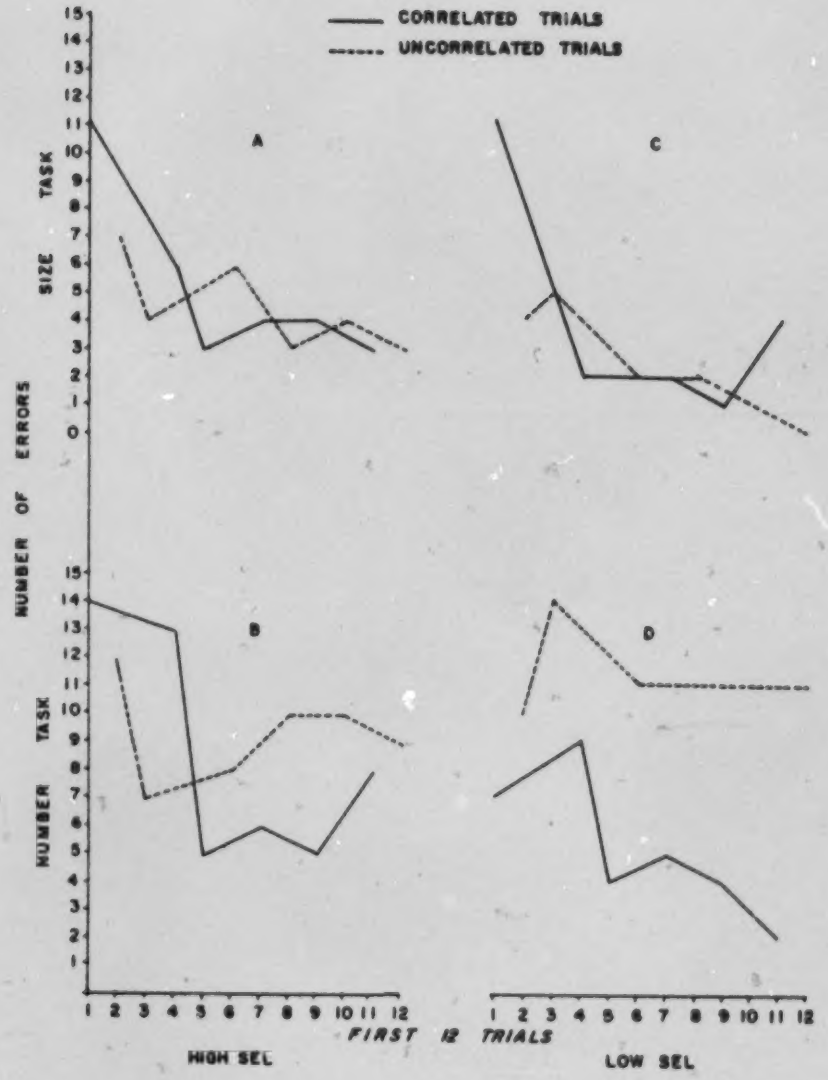

Figure 5. Number of errors on correlated and uncorrelated trials in the first two blocks of trials for (a) high SEL on size task, (b) high SEL on number task, (c) low SEL on size task, (d) low SEL on number task. Trials 1, 4, 5, 7, 9, 11 are correlated trials; trials 2, 3, 6, 8, 10, 12 are uncorrelated trials.

lated trials. There are several possible explanations for the fact that the preference of the low SEL subjects to select the larger of the two stimuli does not operate prior to the first correct response. One is that the subjects do not form hypotheses on the first few trials, which would not be surprising since on the practice trials buttons are not even used, and size is not a dimension. Another possibility is that the preference of the low SEL subjects for selecting the larger buttons does not operate until it has been reinforced. The data from the control groups was most uninteresting and a disappointment.

The second experiment will be devoted to contrasts with an adequately large control group. An analysis of the transfer task showed a significant effect of task (transfer for size versus transfer for number), $F(1,72) = 19.351$, $p < .01$, and the SEL by task interaction, $F(1,72) = 5.397$, $p < .05$. For both SEL groups the transfer test for size was easier than transfer test for number, i.e., the test trials after the number problem were easier than the test trials after the size problem. The interaction between SEL and task was in the same direction as the means for the acquisition trials, and in the case of the transfer task, the interaction was significant.

The striking result of the experiment, therefore, was the fact that the low SEL children maintained a partially successful size hypothesis on the number problem. It is generally considered that subjects on a concept formation problem select hypotheses and maintain them until they make an incorrect response, at which time they reject the hypothesis and sample a new one. If the hypothesis produces the correct response they stay with it. If the hypothesis produces an incorrect response, they shift to a new hypothesis. This strategy is known as "win-stay, lose-shift." The low SEL subjects did not

display this win-stay, lose-shift behavior, but continued to perseverate on a partially reinforced hypothesis. On the number tasks the size hypothesis produced approximately 75% reinforcement and the subject persisted on the size hypothesis.

The purpose of the next experiment was to attempt a replication of Experiment I, using an adequate control group. Since the interesting result of Experiment I was the behavior of the low SEL subjects on the size and number tasks, only low SEL children were sampled for this study. The apparatus and instructions given to the subject were identical to the mechanical reinforcement condition of Experiment I. The failure to obtain a significant result for reinforcement conditions in the previous study was sufficient justification for the discontinuation of that variable.

The subjects in Experiment II were 64 children, 5 1/2 to 6 1/2 years of age, sampled from the Head Start program. All children had met the program's economic criteria for eligibility. The subjects were sampled such that 1/4 were white boys, 1/4 black boys, 1/4 white girls, and 1/4 black girls.

All subjects received 60 acquisition trials, on each of which the stimuli were two plastic clothing buttons presented in the tray. One-half of the subjects had the size task, and one-half had the number task. For both tasks, the buttons differed in color, size, and number of holes. For each of the two tests, there were twelve different pairs of buttons which were repeated in the same order five times. For both tasks, color was a random dimension. For one-half of the subjects run on the size task, a correlated size procedure was used, and for the other half of the subjects, a control size procedure was used. Likewise, one-half of the number task subjects had correlated number, and one-half control number.

For either size task, the correct button was always the larger of the two. For six of the twelve pairs, size was related positively to number of holes; that is, the larger button was also the button with more holes. For the remaining six pairs the larger and smaller buttons had the same number of holes. For no pairs, therefore, were size and number of holes negatively related. This procedure was called a correlated-size task. A trial on which size and number were positively related was called a correlated trial. A trial on which the numbers were equal was called an equated trial.

For three of the twelve pairs of buttons for the control-size task, size was related positively to number of holes; that is, the larger button was also the button with more holes. For three of the pairs size was negatively related to number of holes; that is, the larger button was the button with fewer holes. For the remaining six pairs the larger and smaller buttons had the same number of holes. Since the overall correlation between size and number was zero, this procedure was called a control-size task. A trial on which size and number were positively or negatively related was called a correlated trial. A trial on which size and number were equal was called an equated trial. The order of correlated trials and equated trials was the same for both the correlated task and the control task.

For the number tasks the correct button was always the one with the greater number of holes. Just as in the correlated size task, for six pairs of the correlated-number task the number of holes was positively related to size, and for the remaining six pairs, the buttons were the same size. Just as in the control-size task, for three pairs of the control-number task, number and size were positively related; for three pairs number and size were negatively related, and for the remaining six pairs the buttons were the

same size.

The subject in all conditions paced himself, since as soon as he responded the experimenter pressed the "right" or "wrong" push button, and if it were the former, the experimenter then immediately presented the next two stimuli. The duration of the session was recorded and was found to vary little among subjects.

The dependent variable was the number of errors on the two types of trials within each block of six trials. For the correlated-size task and the correlated-number task, there were three trials within each block of six for which the two variables were positively related and three trials within each block of six for which the irrelevant dimension was equated in value for the two stimuli. Therefore, two points can be obtained for each block of six trials, one for the correlated trials and one for the equated trials. The graphical presentations and analysis of variance used this separation of correlated and equated trials within each block of six. For the control groups of both size and number tasks, the identical trial separation was considered. For the control groups the correlated trials were, therefore, half positively and half negatively related and the equated trials were unaltered. Figure 6 shows the total number of errors in each subset of three

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Insert Figure 6 about here
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trials for the correlated-number task and the control-number task. An inspection of the figure shows that the two sets of trials are undifferentiated in the group which ran on the control-number task. The group run on the correlated-number task displayed a greater number of errors on the equated trials than they did on the correlated trials. Figure 7 shows the results for the

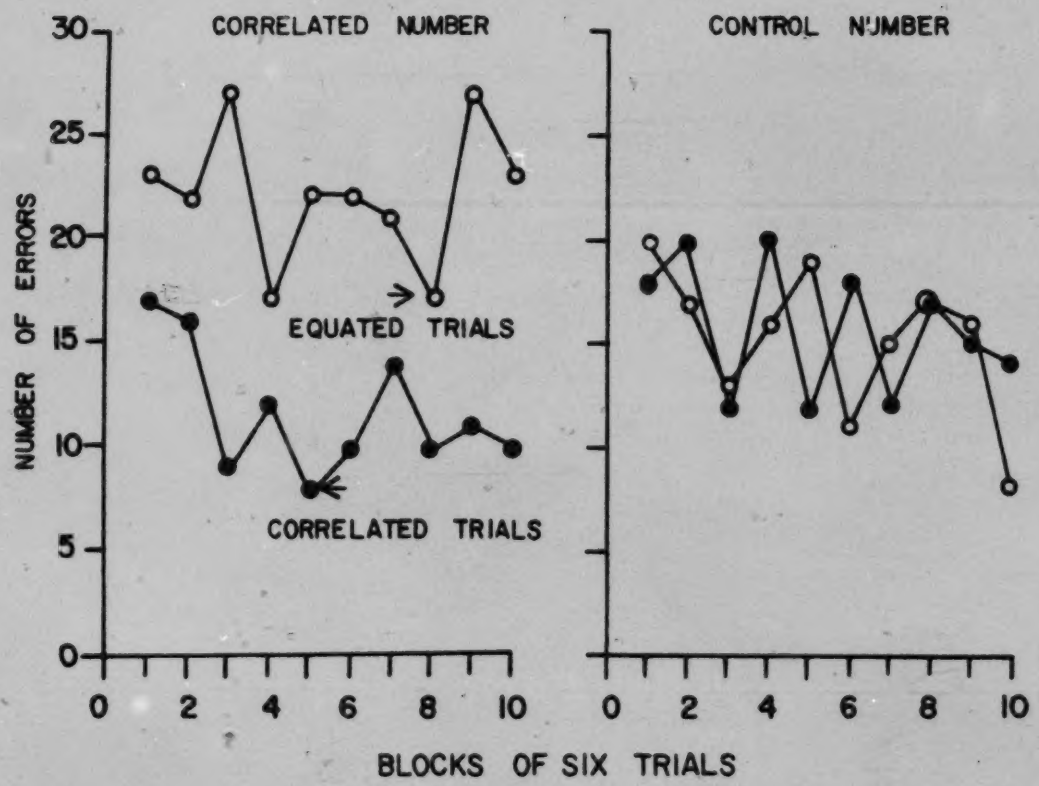

Figure 6. Total number of errors for correlated-number and control-number tasks showing correlated and equated trials in blocks of six trials. (Each point represents the sum of three trials. Size is a cue on the correlated trials of the correlated-number task.)

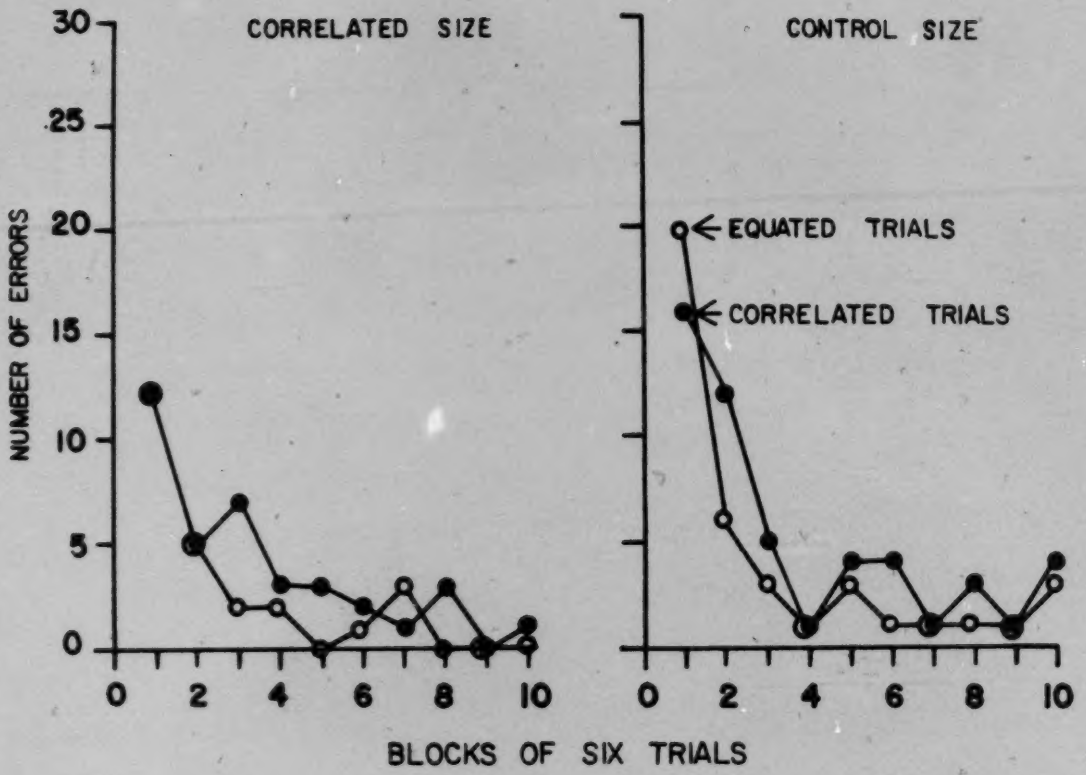

Figure 7. Total number of errors for correlated-size and control-size tasks showing correlated and equated trials in blocks of six trials. (Each point represents the sum of three trials. Number is a cue on the correlated trials of the correlated-size task.)

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correlated-size-task and the control-size-task groups and it is evident that there was no difference between the two groups in terms of total number of errors. It is also evident that there was no difference for either group between the equated trials and the correlated trials.

The anlaysis of variance corresponding to these two figures is given in Table 2. There was a significant difference between size and number tasks

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and between correlated and equated trials. There was also a significant interaction of Size-Number Task X Correlated-Equated Trials. Equally of interest, the interaction Correlated-Control Task X Correlated-Equated Trial was significant. The last meaningful significant effect was the triple interaction Size-Number Task X Correlated-Control Task X Correlated-Equated Trial. All hypotheses were, therefore, confirmed. There were no significant effects or interactions due to the race or sex of the subjects except the quadruple interaction with size-number task and correlated-control task, which had no readily apparent interpretation.

The results of the experiment indicated that use of appropriate size and number tasks produces the same effects as an experimental manipulation of stimulus discriminability (Archer, 1962). The selection of size and number tasks for this population of subjects produced the interaction Obviousness X Partial Reinforcement that can be obtained in studies which manipulate the stimulus variables (Abraham, Gormezano, & Wiehe, 1964). Therefore, one has an experimental confirmation and elaboration of the fact that size comes

TABLE 2

Analysis of Variance for Number of Errors

Source	df	MS	F
Size-Number Task (A)	1	1883.445	53.113**
Correlated-Control Task (B)	1	0.070	
Race (C)	1	13.133	
Sex (D)	1	0.195	
A X B	1	27.195	
A X C	1	7.508	
A X D	1	59.133	
B X C	1	7.508	
B X D	1	6.570	
C X D	1	35.070	
A X B X C	1	41.633	
A X B X D	1	7.508	
A X C X D	1	114.383	
B X C X D	1	37.195	
A X B X C X D (Groups)	1	178.133	5.023*
Subjects within Groups	48	35.461	
Correlated - Equated Trials (E)	1	51.258	5.005*
E X A	1	103.320	10.088**
E X B	1	86.133	8.410**
E X C	1	0.945	
E X D	1	35.070	
E X A X B	1	103.320	10.088**
E X A X C	1	2.258	
E X A X D	1	15.820	

TABLE 2 (Continued)

Source	df	MS	F
E X B X C	1	2.820	
E X B X D	1	14.445	
E X C X D	1	0.070	
E X A X B X C	1	4.883	
E X A X B X D	1	37.195	
E X A X C X D	1	0.071	
E X B X C X D	1	5.695	
E X A X B X C X D	1	6.570	
E X Subjects within Groups	48	10.242	

* $p < .05$.

** $p < .01$.

earlier in development than number, and that the effects of this difference extend to more complex phenomena of learning.

The results of Experiment II serve as a replication of Experiment I. Young children from a low socioeconomic level do not adopt a win-stay lose-shift strategy in concept formation tasks. They tend to perseverate on a dimension high on their hierarchy when the corresponding hypothesis is partially reinforced. Young children from a high socioeconomic level adopt a win-stay lose-shift strategy which ultimately results in near perfect performance even when the 100% reinforced hypothesis corresponds to a dimension low on their hierarchy. The results of the present study show that partial reinforcement of size leads to the adoption of a size hypothesis by the low socioeconomic level subjects when a number hypothesis would have been reinforced 100% of the time.

There was no effect of unequal number during a size task, but unequal size during a number task resulted in poorer performance. The subjects in a size task did not respond differentially to stimuli equated or unequated on the number dimension; the subjects on the number task did respond differentially to stimuli equated or unequated on the size dimension. To paraphrase, the subjects were more responsive to size than number.

There was no effect of correlated trials on the control task, but correlated trials during the correlated task had fewer errors than did equated trials during the correlated task. This interaction occurred only during a number task and not during a size task.

In terms of the graphical presentations of the data, there were no differences among the four curves for the size task; for the number task, the correlated and equated trials of the correlated-number group straddled the

two curves of the control-number group.

The previous two experiments showed that low SEL children do not adopt a win-stay, lose-shift strategy in a concept acquisition task. It was hypothesized from these data that low SEL children perform less successfully in concept attainment problems because of their inconsistent reinforcement histories. Experiment III was planned, therefore, to investigate whether the introduction of chaotic reinforcement into the histories of high SEL children would lead to a comparable decrement in their performance.

The subjects were 60 first graders, with a mean age of 7 years. One-half of the subjects were from a high SEL and one-half from a low SEL. In each SEL group one-half were boys and one-half girls. The selection of subjects and the indices used to determine SEL were the same as those employed in Experiment I, with the previously noted exceptions of grooming and quality of residence.

In this third experiment the first n trials were randomly reinforced. After the n random trials with no clues given to the subject, the actual concept acquisition trials began and consistent reinforcement continued thereafter. The apparatus was a Lehigh Valley Electronics human intelligence panel. Mounted on the panel were a dual, multi-stimulus response key apparatus and a one-cent reinforcement delivery condition. The experimental procedure was controlled by automated electronic equipment, and all responses and stimuli were recorded on a six-channel event recorder. The subjects were individually seated in front of the Lehigh Valley console on which two different figures on two different color backgrounds were presented on each trial. A finger press against the stimulus activated a microswitch. Each correct response was rewarded with a penny. The use of a correction procedure required the

subject to press the correct key if his initial response did not result in a reward. No penny was given for a response correction. The subject was told that he was going to play a little game with lights in each of the two openings. It was demonstrated to him that if he selected the correct light he would get a penny, and that if he selected the incorrect light he would then have to press the correct one, although he would not get a penny. In any case, he was asked to leave the pennies in the dispenser until the completion of the game, at which time he would be able to take them home. The subject was requested to wait until the lights changed before beginning to play the game. He was allowed to use only one hand. The first trial consisted of two stimuli that were never again used. This served as a check on the subject's ability to follow directions. The actual experimental stimuli consisted of a triangle and a circle, one on a red background and the other on a green background. The four permutations of form and color, GT-RC, RC-GT, GC-RT, RT-GC, appeared with equal frequency in an unsystematic order. The 30 subjects in each SEL group were divided into three subgroups of ten subjects each.

One-third of the subjects began immediately on the concept acquisition task in which the triangle was always reinforced. One-third of the subjects had six trials in which the triangle and circle were randomly reinforced prior to the beginning of concept formation. One-third of the subjects had twelve trials in which triangle and circle were randomly reinforced prior to the beginning of concept formation. The red or green color and the positions of the circle and the triangle were never relevant stimuli. All subjects were run at least 42 trials. If the criterion of twelve correct responses in succession was not reached within the first 42 trials, the run was con-

tinued until the criterion was reached up to a maximum of 120 trials.

The number of errors in the first 42 trials, divided into seven blocks of six trials each, can be seen in Table 3. An analysis of variance calcu-

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lated from these data is shown in Table 4. Three main effects were signifi-

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cant: SEL, Number of Random Reinforcements, and Trials. The high SEL children made fewer errors than the low SEL children on all tasks combined. Errors increased with an increase in the number of random reinforcements. Errors decreased over the seven blocks of trials. When the interaction of SEL X Number of Random Reinforcements was partitioned into two orthogonal comparisons, 12 and 6 vs. 0, and 12 vs. 6, only the former was significant. This significant result can be explained by the fact that with six or twelve random reinforcements the high SEL subjects became progressively more similar to the low SEL subjects in performance (Figure 8). There were almost identi-

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cal results from the high and low SEL subjects run under twelve prior random reinforcements. The significant SEL X Trails interaction resulted from the fact that the high SEL children improved more than the low SEL children over trials (Table 3).

Nonparametric statistical tests computed on the data for number of trials to criterion in 120 trials yielded the same general results. Tests for independent samples (Wilcoxon, 1947) were used to compare the high SEL

TABLE 3

Number of Errors in First 42 Trials

of Consistent Reinforcement

	No. of Random Reinforcements	Blocks of six trials 1	2	3	4	5	6	7	Total
High SEL	12	33	31	20	19	24	24	28	179
	6	29	26	26	18	17	23	12	151
	0	18	13	13	6	2	3	1	56
		80	70	59	43	43	50	41	386
Low SEL	12	31	27	24	30	22	24	22	180
	6	25	28	25	25	25	16	25	172
	0	24	16	25	22	22	16	20	145
		80	71	77	77	69	56	67	497
Total		160	141	136	120	112	106	108	883

Table 4

Analysis of Variance for Number of Errors

Source	df	MS	F
(SEL) A	1	29.3357	5.4289*
(No. of Random Reinforcements) B	2	48.9809	9.0645***
(Sex) C	1	8.8596	1.6396
A X B	2	15.2000	2.8129
12 + 6 vs. 0	1	28.9714	5.3615**
12 vs. 6	1	1.4286	.2644
A X C	1	.9128	.0357
B X C	2	15.1238	2.7988
A X B X C	2	4.3285	.8010
Ss within groups	48	5.4036	
(Blocks of Six Trials) E	6	6.7690	6.3003***
A X E	6	3.0802	2.8669*
B X E	12	1.1643	1.0837
C X E	6	.9040	.8414
A X B X E	12	1.5111	1.4065
A X C X E	6	.5040	.4691
B X C X E	12	1.0182	.9477
A X B X C X E	12	1.4397	1.3400
E X Ss within groups	288	1.0744	

*p .05

**p .01

***p .001

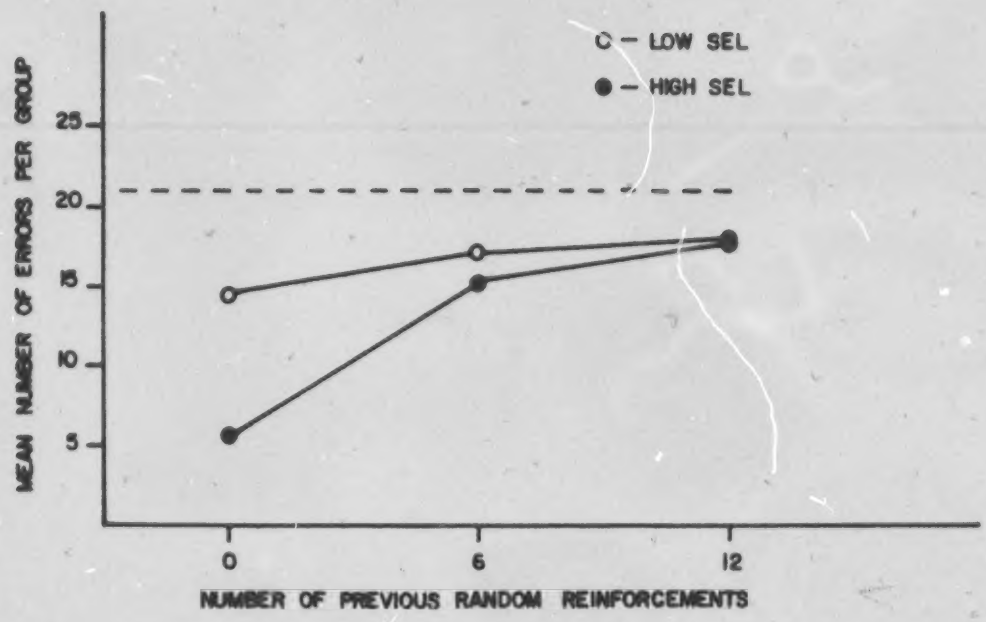

Figure 8. Mean number of errors for each group of 10 subjects for 42 trials. (The broken line denotes chance level of performance.)

scores with the low SEL scores. After either twelve or six random reinforcements there was no significant difference between the two SEL groups. After zero random reinforcements the number of trials to criterion was significantly different ($T = 76.5$, $p < .05$); the overall result combining the three T's also yielded a significant difference between the high and low SEL groups ($T = 255$, $p < .01$).

The number of errors for each of the six groups shown in Figure 8 was significantly superior to the chance level of 21 errors per subject; the smallest z-value so obtained was 2.928.

The experiment demonstrated that the introduction of random reinforcement produces typically low SEL behavior in high SEL subjects. It was shown that this result was not a simple consequence of all concept acquisition degenerating to a chance level. Both number of errors and trials to criterion revealed that the high SEL performance progressively approached and ultimately equaled the ineffectual low SEL performance. The data add credibility to the hypothesis that the inferior performance of low SEL children is a function of their chaotic or inconsistent reinforcement histories.

Experiments IV and V were designed to investigate the conditions under which subjects would change their hypotheses during concept acquisition. Both experiments employed pretraining on a concept and subsequent shifting to partial confirmation of that concept. Experiment IV utilized differing degrees of overlearning prior to the shift to partial confirmation. Experiments I and II had shown that low SEL subjects did not shift from a partially reinforced hypothesis which was high on their hierarchy. Experiment III showed that high SEL subjects, after random reinforcement, demonstrated similarly inferior concept acquisition behavior. Experiment IV was designed to

investigate the conditions under which subjects would or would not shift from a nonconfirmed hypothesis as a function of the degree of original learning and the frequency of nonconfirmation.

The subjects in Experiment IV were 90 first grade children with color vision, one-half of them boys and one-half of them girls. The subjects were randomly sampled from schools which had been identified as being located in areas neither predominatly high SEL nor predominantly low SEL.

The experiment was conducted in a mobile laboratory which was parked outside of each school. The Lehigh Valley human intelligence panel of the previous experiment was again used. This time the task was simplified so that on each trial a red and a green light were presented. The position of the two lights was the irrelevant dimension. The subject was shown the two lights and instructed to press one of the keys. If he made the correct response, he received a trinket. An assortment of trinkets was presented by a universal feeder into a receptacle whose clear plastic top was closed during the experiment. The subject was told that he would be able to take the trinkets home after the experiment. The intertrial intervals and stimuli were automatically controlled, and responses and stimuli were recorded on event markers.

The subjects were brought individually into the laboratory and told that they were going to play a game with the two push buttons. They were shown that when they pressed the correct button, both lights would go out and a toy would fall into the tray. When the lights came back on, they were again to press one of the buttons. If the lights blinked and no toy was obtained, the response had been incorrect and they were asked to then press the correct button so that they could turn out the lights and have another turn.

The red key was always the correct key to press. If the subject chose the red key first, the lights went off for a 3-second period after which a toy was received, and the next trial began. If he pressed the green key the lights went out for 30 msec. and a correction response had to be made without reinforcement. In this first phase of the experiment, the subjects received trinkets on a 100% schedule until a criterion run was completed. For one third of the subjects, the criterion run was defined as six correct responses in succession. For one-third, criterion was twelve responses. For the remaining one-third, criterion was 18 correct responses in succession. Following completion of the run, partial reinforcement of the red key response was introduced without any indication to the subject. For one-third of the subjects, the partial reinforcement was 90%, for one-third, reinforcement was 80%, and for one-third, reinforcement was 70%. The partial reinforcement schedules were continued for 60 trials.

The dependent variable was the number of errors during the 60 trials of partial reinforcement. An error was defined as any trial in which the first response was not the choice of the red button. Therefore, during partial reinforcement, if the subject pressed the red key and did not receive a confirmation, he might be expected to shift to the green key on the following trial. Any response to the green key was called an error. The results are shown in Figure 9. Table 5 contains an analysis of variance which demon-

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strated that the number of trials required to criterion before the shift to

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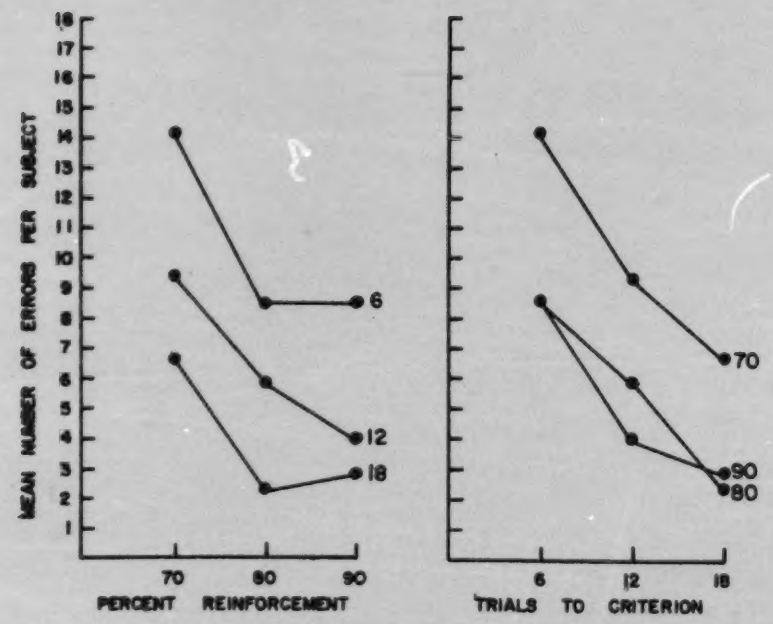

Figure 9. Mean number of errors per subject during the partial reinforcement test as a function of the training criterion and the testing percentage of confirmation. The number of errors is the number of response shifts during the last 60 trials on which the original response confirmation was 70%, 80%, or 90%. The right hand figure shows the result as a function of the original number of trials to criterion, 6, 12, or 18. The left hand figure shows the result as a function of the percentage of reinforcement, 70%, 80%, or 90% to which the subjects were shifted.

TABLE 5

Analysis of variance for 60 partially reinforced trials with number of errors (response shifts) as the dependent variable.

Source of variation	df	SS	MS	F
A(Sex)	1	9.3444	9.3444	
T(Trials to criterion)	2	629.4222	314.7111	6.9163**
P(Percent reinforcement)	2	422.9555	211.4778	4.6476*
A x T	2	32.6223	16.3111	
A x P	2	3.6223	1.3111	
P x T	4	25.6445	6.4111	
A x T x P	4	129.9110	32.4778	
S_wG(Subjects within groups)	72	3276.2000	45.5028	

** $p < .01$
* $p < .05$

partial reinforcement had a significant effect upon the number of errors during partial reinforcement. The percentage of reinforcement (the proportion of nonconfirmations) had a significant effect upon the number of errors (the number of times the subject shifted to the green stimulus). This latter difference was attributable to the discrepancy between the 70% condition and the 80% and 90% conditions combined, $F(1,72) = 9.455$, $p < .01$. No other components of the analysis were significant.

The results clearly demonstrate that although concept formation is considered an all-or-none process, there is also a cumulative effect. The longer the criterion run in phase I, the less likely the subject is to shift after a nonconfirmation during the second phase of partial reinforcement. The results also demonstrate that if the proportion of nonconfirmations becomes high enough (30%) in phase II, there is an increased tendency for the subjects to shift out of their previously reinforced hypothesis. The number of errors during partial reinforcement increased considerably.

Experiments IV and V differed only in the pretraining of phase I. In Experiment IV, the pretraining groups were defined by the number of criterion trials, irrespective of total number of trials; in Experiment V, the pretraining groups were defined by a fixed number of trials, independent of the subject's performance. The subjects for Experiment V were 90 first-grade children with color vision, sampled from the same schools used in Experiment IV. The apparatus and instructions were identical to those employed previously. One-third of the subjects in this experiment received 12 trials before the shift to partial reinforcement, one-third of the subjects received 24 trials, and one-third of the subjects, 36. After the 12, 24, or 36 trials, the subjects were then shifted to 70%, 80%, or 90% partial reinforcement.

There were again nine groups, each made up of half boys and half girls.

The values 12, 24, and 36, were selected because they represented the number of trials required to reach criterion by approximately 50%, 70%, and 90% of the subjects in Experiment IV during phase I.

The dependent variable was again the number of errors during the 60 trials of partial reinforcement. An error was defined as any choice of the green key. The results are shown in Figure 10. Table 6 contains an analysis of

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variance, which yielded no significant effects. With partitioning, however, the discrepancy between the 70% condition and the 80% and 90% conditions combined was significant, $F(1,72) = 5.115$, $p < .05$. The 12-trial condition compared to the combinations of the 24- and 36-trial conditions was not significant.

The experiment, when compared with the results of Experiment IV, clearly demonstrate that the percentage of nonconfirmations is a significant variable when that percentage is sufficiently high. On the other hand, the sheer number of trials on which a subject is pretrained is not a significant variable whereas the number of trials to criterion is significant. Once the subject has learned the correct hypothesis, the number of subsequent trials affects the probability of shifting, given a nonconfirmation of the correct hypothesis in phase II. In Experiment V when the procedure did not guarantee that the subjects had all learned the correct hypothesis, the actual number of trials was not a significant variable. In Experiment V there was greater

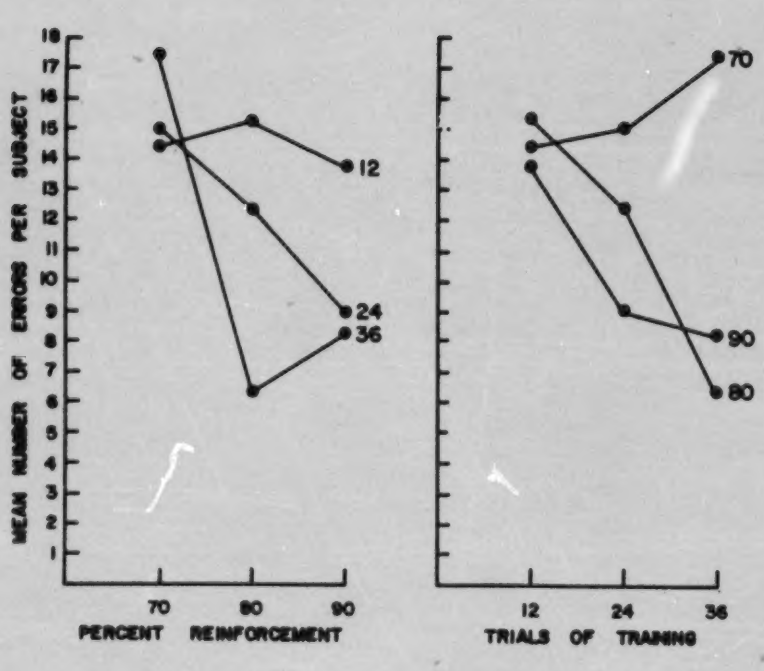

Figure 10. Mean number of errors per subject during the partial reinforcement test as a function of the number of training trials and the testing percentage of confirmation. The number of errors is the number of response shifts during the last 60 trials on which the original response confirmation was 70%, 80%, or 90%. The right hand figure shows the result as a function of the original number of training trials, 12, 24, or 36. The left hand figure shows the result as a function of the percentage of reinforcement, 70%, 80%, or 90% to which the subjects were shifted.

TABLE 6

Analysis of variance for 60 partially reinforced trials with number of errors (response shifts) as the dependent variable.

Source of variation	df	SS	MS	F
A(Sex)	1	30.0445	30.0445	
N(Number of trials)	2	228.0223	114.0112	1.3107
P(Percent reinforcement)	2	460.9556	230.4778	2.6497
(70 vs. 80 + 90)	1	444.9389	444.9389	5.1152*
A x N	2	270.1555	135.0775	1.5529
A x P	2	188.4222	94.2111	1.0831
N x P	4	414.3777	103.5944	1.1910
A x N x P	4	489.1778	122.2944	1.4060
S_wG(Subjects within groups)	72	6262.8000	86.9833	

*$p < .05$

variance between subjects because some subjects had acquired the concept during pretraining and some had not; in Experiment IV there was less variance between subjects because all subjects had acquired the concept in pretraining. The result of Experiment V was not significant; the error term had almost doubled.

Discussion of Concept Formation

Theoretical accounts of concept formation have turned from response strengthening to hypothesis testing (Krechevsky, 1932; Lashley, 1929, p. 135). The subject has been viewed as formulating an hypothesis and retaining the hypothesis if his response is called "right" and rejecting his hypothesis and formulating a new one if his response is called "wrong." This strategy has been referred to as "win-stay, lose'shift" (Goodnow and Pettigrew, 1955). Various models have been constructed to account for the method of shifting. All have involved the random selection of a new hypothesis from some subset of the opulation of all possible hypotheses. (See Levine, Yoder, Kleinberg, & Rosenburg, 1968; or Gregg & Simon, 1967, for a description of the specific models.) Elaborate mathematical models have been constructed to formalize and quantify predictions generated by win-stay lose-shift. Variables such as the number of errors prior to the first correct response and the stationary probability of the correct response have been investigated (e.g., Suppes & Ginsburg, 1963). In spite of occasional failures (e.g., Erickson, 1968) the basic notion of hypothesis sampling has been retained.

The results of Experiments I and II clearly demonstrate that the low SEL subjects do not display the expected behavior. They form an hypothesis which governs their selection of the larger stimulus; nonconfirmation of

this hypothesis does not result in their shifting to a new hypothesis. Instead of displaying the win-stay lose-shift behavior, they display a win-stay lose-stay behavior. The results of Experiments III, IV, and V provide us with some insight into this tendency to perseverate on a partially reinforced hypothesis.

Experiment III utilized a procedure previously employed by Levine (1962). The random reinforcements at the beginning of training produced a devastating effect upon the performance of the high SEL subjects. This certainly raises the possibility that inconsistent, if not random, reinforcement contingencies in the experiential history of low SEL subjects is at best partially responsible for their typical performance on concept acquisition tasks. When the high SEL subjects received as few as six random reinforcements, they performed almost as poorly as the low SEL subjects on the subsequent concept task. When the high SEL subjects received as many as twelve random reinforcements, they performed equally as poorly as the low SEL subjects on the subsequent concept task. There is little question that relatively little chaos can produce a large degredation of concept acquisition.

Experiment IV yielded results which implicate another possible factor in the performance of low SEL children. Experiment IV was conducted with children from the middle range of SEL. It demonstrated that overlearning can result in a resistance to changing behavior. Subjects were trained until they acquired a concept to a criterion of 6, 12, or 18 correct responses in succession. Since the subjects must have learned the correct hypothesis just prior to the criterion run, the procedure may be viewed as a manipulation of the number of overlearning trials, 6, 12, or 18. The subjects

were then shifted to a partial reinforcement (confirmation) schedule of 70%, 80%, or 90%. The results showed that the greater the number of overlearning trials the fewer the number of shifts during partial reinforcement. Although concept acquisition is normally thought of as "all-or-none" it is clear that the greater the number of confirmations after learning has occurred, the less readily the subject shifts from the learned hypothesis. To paraphrase this, the greater the number of win-stay occurences, the less apt the subject is to shift after a lose. In Experiments I and II it had been seen that low SEL subjects do not adopt a win-stay lose-shift strategy in concept formation. Experiment III raised the possibility that this failure to display a win-stay lose-shift strategy could result from chaotic reinforcement. Experiment IV raises the possibility that this failure to display the win-stay lose-shift strategy could result from overlearning. Experiment V was a manipulation of the number of training trials independent of the subjects' behavior; the number of training trials had no effect upon response shifting during the subsequent partial reinforcement. Experiment V demonstrates that the effect is attributable to the number of confirmations after learning has occurred and not to the total number of confirmations, i.e., the result of Experiment IV is produced by overlearning.

A third possible factor may account for the failure of the low SEL subjects to display win-stay lose-shift behavior in Experiments I and II. Perseverating on an incorrect hypothesis enabled the subjects to obtain 75% reinforcement, a percentage which can be conjectured to be higher than their customary level. A direct test of this hypothesis would be very difficult, but Experiments IV and V both demonstrate that the tendency to shift after a nonconfirmation is a function of the relative frequency of

nonconfirmations. Shifting is more frequent with 70% confirmation than with 80% or 90% confirmation.

We end up with the following picture. Low SEL subjects do not adopt a win-stay lose-shift strategy displayed by high SEL children and by adults. They perseverate on a hypothesis high on their heirarchy possibly because 1) they have had a great deal of overlearning on that hypothesis, and 2) the rate of partial reinforcement is sufficiently high. The net result is that low SEL subjects are not only slow in learning new solutions but are conversely slow in giving up old solutions. We shall see this general theme repeated with respect to both reward preferences and observing responses.

Reward Preferences

Experiment VI was concerned with the preferences of young children for joint probability-magnitudes of reinforcement when the overall mean quantity of reinforcement was the same in a two-choice situation. The purpose of the study was to extend the two-choice equal mean reinforcement paradigm used in the elegant studies of the rat to human subjects. There have been two studies of children's preferences with equalized mean reward for the choices, but both have incorporated the additional factor of risk (Cohen, 1960; Cass, 1964). From social and educational perspectives the experimental design is of interest because systematic methods of behavioral shaping at home and in school depend upon information pertaining to the child's preferences in the context of his reinforcement history. Furthermore, our studies of concept acquisition showed that the percentages of reinforcement required by high and low SEL subjects may be different.

The subjects were 60 white, male, preschool children. Their ages

ranged from 4 1/2 years to 5 1/2 years. Half of the subjects constituted the low SEL subgroups and half constituted the high SEL subgroups. The members of these groups fall into Warner, Meeker, and Eells' (1949) lower lower or upper middle and high classifications.

The experimental apparatus was a specially constructed peanut vending machine. It was a two choice key press device, with a blue light and a "Mr. Peanut" bank. Doors in front of the keys allowed the experimenter to make either or both of the keys available to the subject on any particular trial. The experimenter sat behind the apparatus panel, working the doors and delivering peanuts to the subject. The subject was told that he was going to play with a peanut machine. He was instructed to watch for the blue light and to press an available key when the light came on. He was shown how the buttons would turn off the lights and sometimes make peanuts come out. The peanuts came down a transparent delivery tube and into a transparent covered dish. The subject was of course told that he could have the peanuts at the end of the experiment.

For each SEL there were three experimental groups. For one of the groups, one key was programmed to deliver one unshelled peanut 100% of the time and one of the keys was programmed to deliver two unshelled peanuts 50% of the time. For the second group, one key produced one peanut 100% of the time and the other key produced four peanuts 25% of the time. For the third group, the choices were between four peanuts 25% of the time and two peanuts 50% of the time. Within each group the key assignments were counterbalanced for the right and left hand sides. All subjects were given 80 discreet trials. In blocks of 8, trials were forced by dropping the guillotine door over the key that first accumulated four responses. The

probabilities were pre-programmed by using all possible permutations. On a reinforced trial, a bell was sounded and "Mr. Peanut" flashed with the delivery of each peanut. The intertrial interval was 4.5 seconds.

It is clear from the experimental design that there is no most efficient or best strategy. Any pattern of responses by the subjects yields the same expected value of 80 units of reinforcement. The intrusion of forced trials, within each block of 8 trials, prevented any consistent perseveration of response choice by the subject. There is much discussion in the observational literature of the discrepancy between the reinforcing characteristics of the high and low SEL environments. This experiment represents our first objective attempt to determine the reinforcement schedule preferences of the two SELs and to determine their strategies following reinforcement and nonreinforcement. As we shall see, the sequence of choices proved most interesting.

Choice proportions were computed for the free trials. Given the null hypothesis of no preference for the higher probability alternative, both the low and high SEL subjects showed a significant preference for the higher probability alternative ($t = 2.709$, $df = 29$, $p < .05$; and $t = 2.696$, $df = 29$, $p < .05$, respectively).

An analysis of variance of the choice proportion data showed that only blocks of trials was significant ($F = 2.5203$, $df = 4/216$, $p < .05$). The mean choice proportions per block of 16 trials for the subgroups are shown in Figures 11 and 12. It is clear that meaningful trends occur in only two

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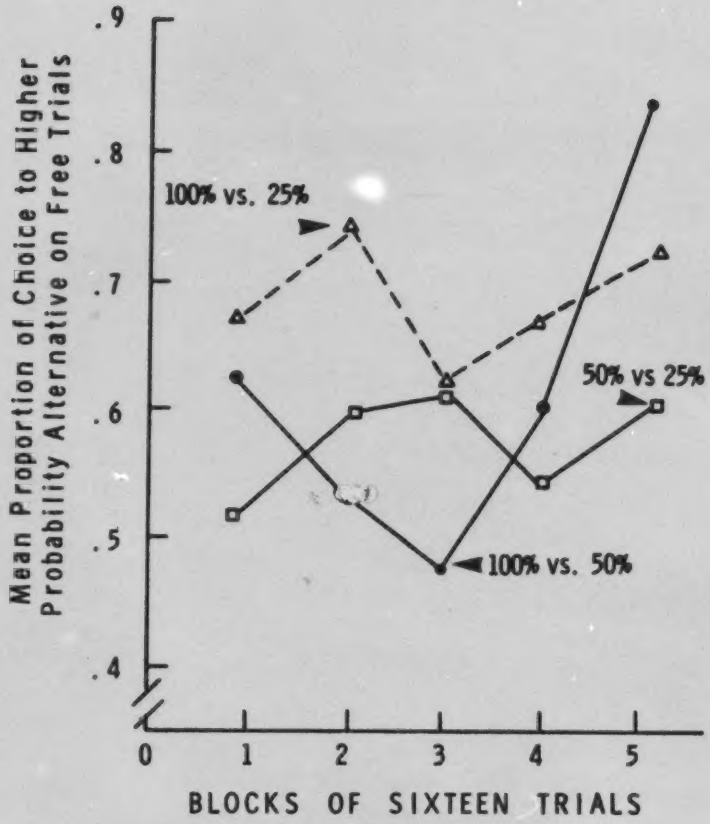

Figure 11. Mean proportion of free-choice trials to higher probability alternative for the three subgroups of high SEL subjects.

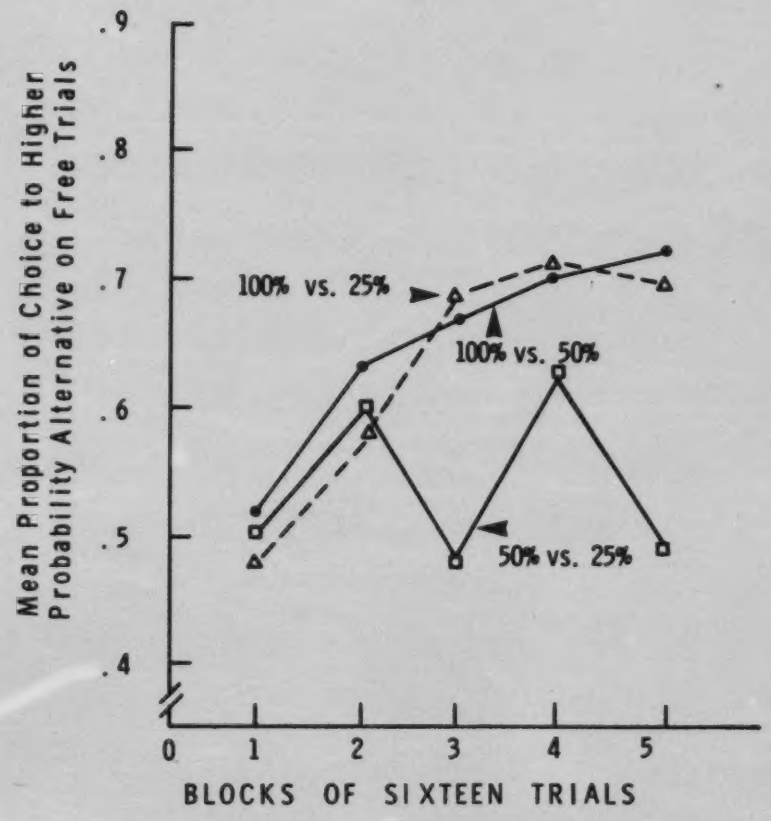

Figure 12. Mean proportion of free-choice trials to higher probability alternative for the three subgroups of low SEL subjects.

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Insert Figure 12 about here
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two of the curves. The low SEL groups, 100% vs. 25% and 100% vs. 50%, indicate a steady acquisition rate.

Each subject's data were analyzed to determine the frequencies with which the subject remained on the same side from Trial N to Trial N + 1, or shifted to the other side. The responses on the 100% side were considered for the four subgroups that were given this value as an alternative. Each subject's data were submitted to a 1 X 2 chi-square test for goodness of fit, where the expected proportion in each cell for all subjects was 0.5. Since the square root of a chi-square for one degree of freedom is equal to z, a standard score frequency distribution was constructed for each group. When a sign was assigned to the z's to denote direction of the lack of goodness of fit, all distributions were negatively skewed. This is related to the finding that both SELs displayed a larger proportion of responses to the 100% alternative. The z values were summed over subjects and divided by the square root of 10 to give an overall z for each group. These data are contained in Table 7. All the z's were significant in the direction of stay-

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Insert Table 7 about here
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ing with the response to the 100% reinforced side from Trial N to Trial N + 1. The difference between two z's divided by the square root of 2 is also equal to z. The low SEL subgroups revealed a significantly greater tendency to stay on Trial N + 1 after reinforcement on Trial N than did the high SEL subjects, $\underline{z} = 4.717$ ($\underline{p} < .01$) for the 100% - 25% groups, and $\underline{z} = 3.682$ ($\underline{p} < .01$) for the 100% - 50% groups.

TABLE 7

Sums of Standard Scores Derived From Stay-Shift Chi-Squares

Subgroup	Z
Low SEL	
100% versus 25%	11.973*
100% versus 50%	11.475*
High SEL	
100% versus 25%	5.302*
100% versus 50%	6.267*

* $p < .01$

There are 112 possible response patterns that a subject can produce given four to seven free trials in each block of eight. The frequencies of occurrence of each pattern for each subject were recorded. Table 8 shows

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the frequencies for the stereotypic pattern (four consecutive responses) to the two response alternatives and the single alteration pattern (ABABABA). The frequencies of all other patterns were pooled into a fourth category. It is clear that the high SEL subjects used the single alternation pattern more than the low SEL subjects did. The use of a statistical test on these data would not be valid because of the lack of independence between entries pooled over subjects and trials; however, these data do provide a rough demonstration of the differences between the groups. The greater variability of the high SEL patterns may also be indicated by the frequency of occurrence of other patterns.

Analyses of variance were run on the latency data, using both mean latency per subject on free trials and latency variance on free trials as dependent variables. Neither the main effects nor the interactions were significant.

The partial correlation matrix for the factors age, subgroup, SEL, and number of forced trials was calculated. The only significant correlation is the inverse relationship between SEL and number of forced trials ($r = -.38919$, $df = 60$, $p < .01$).

In summary, this investigation, Expriment VI, was carried out to explore the effects of presenting preschool children with choices that yielded the same mean reinforcement but differed in magnitude-probability scheduling of

TABLE 8

Observed and Expected Frequencies of Response Sequences

Group	Stereotype		Single alternation	Other	Total
	High %	Low %			
Low SEL	141 (122)	75 (57)	0 (13)	84 (108)	300
High SEL	103 (122)	39 (57)	26 (13)	132 (108)	300
Total	244	114	26	216	600

Figures in parentheses are expected frequencies.

outcomes. For each of the SEL groups, it was found that higher probabilities and lower magnitudes were preferred to lower probabilities and higher magnitudes. All subgroups in which 100% was an alternative chose significantly to remain on that side following reinforcement rather than shift to the other set of values. Response latency means and variances did not differ significantly between subgroups or SELs.

In general, the findings for preference for continuous reward are in agreement with the results from studies using rats. The results are also in accord with the finding that young children prefer predictable to nonpredictable reinforcement (Lewis, Wall, & Aronfreed, 1963).

When the data were analyzed for SEL differences, clearly contrasting approaches to the task appear for the two groups. The two low SEL subgroups receiving 100% as an alternative showed a significantly stronger tendency to perseverate on a response following reinforcement than did the high SEL subgroups. This finding is logically consistent with the data for response sequencing that yields a tendency on the part of the low SEL subjects to use stereotyped patterns to both the generally preferred 100% alternative and the generally nonpreferred 25% and 50% alternatives. Since low SEL subjects chose less complex, shifting, or flexible patterns, it is expected that they would receive forced trials earlier in an eight-trial block and would receive more forced trials overall than high SEL subjects, which was the case. The low SEL subjects used more perseverative sequences, and the high SEL subjects used a greater number of response patterns on the basically insoluble task (since both alternatives in any pair yielded the same mean reward).

Several inferential explanations may be applied to the differences in

response modes used by the two SEL groups. It can be speculated that the low SEL subjects generally responded to the just previous response's effect. They responded, perhaps, in a simply instrumental manner, for the most part, seeing success as consistent reinforcement (Wycoff & Sidowski, 1955).

Many of the high SEL subjects' response sequences, especially single alternation responses, may be considered as strategies. They may have committed the "gambler's fallacy" assuming that a payoff on Trial N + 1 is less likely on the same alternative that paid off on Trial N. Other investigators found that their subjects preferred to predict correctly the least likely event than the most likely (Brackbill & Bravos, 1962; Siegel, 1959). This motive may have been operative in the present study.

Regardless of the subjects' motives, it is likely that the high SEL subjects more frequently employed "cognitive" strategies than did the low SEL subjects.

The low SEL subjects were bound by the outcomes of the just previous trials, while the high SEL subjects were more able to discriminate between the overall contingencies. The behavior of the high SEL subjects, was, therefore less stereotyped.

To pursue further the findings of Experiment VI, Experiment VII was designed to investigate the behavior of 48 third-grade children from high and low SELs under three percentages of reinforcement. The reinforced trials were either signalled or unsignalled. A simple manual task was chosen to minimize the effects of intelligence or previous learning. Other investigators (Espenschadi, 1946; Moore, 1941, 1942; Rhodes, 1937) have not found significant differences between high and low SEL children or between black

and white children on manual dexterity and eye-hand coordination tasks. In Experiment VI simple reward preferences were studied; in Experiment VII the rate of performance on a simple motor task was measured as a function of the reinforcement on the previous trial and the presentation of a signal for reinforcement on the current trial.

Twenty-four subjects were selected from the third grade of a school in a high SEL neighborhood. One-half of the children were white girls and one-half were white boys. Twenty-four subjects were sampled from the third grade of a school in a low SEL area of the city. One-fourth of the children were white girls, one-fourth were black girls, one-fourth white boys, and one-fourth black boys. The mean age of the high SEL subjects was 8.91 years and the mean age of the low SEL subjects was 8.95 years.

The apparatus consisted of a plywood cabinet 16 x 24 x 1 1/2 in. with an upright rear panel. When placed on a desk top at a comfortable height for the seated subject it formed a flat work area with the panel screening the activities of the experimenter from the subject's view. On the right-hand side of the work area was a 10 1/2 x 11 1/2 in. hole in the plywood, under which was mounted a 400-hole, square plexiglass pegboard. Ten individual pegboards were made of masonite with black metal handles. These were fitted into the hole in the cabinet over the 20 x 20 pegboard matrix. Each individual board had 20 holes, arranged randomly with one corresponding to each row and column of the matrix. When the individual test board was in place, brightly colored banana plugs or "pegs" could be inserted through the holes in both boards to make electrical contact with forty 3/32 in. brass rods mounted beneath the rows of the matrix. These rods were

wired so that insertion of the first peg, anywhere in any row, activated a timer located behind the panel facing the experimenter. With the insertion of the twentieth peg all the rows were filled and the timer was shut off automatically, giving an accurate measure of the time taken to fill the board.

Above the pegboard area on the panel were a 12 x 2 1/2 in. slot for dispensing and receiving boards, and a 1 x 4 in. slot with a peg chute and tray. Pegs were fed into this tray manually at regular intervals by the experimenter. On the right-hand side of the panel was mounted a Lehigh Valley Electronics coin dispenser. This dispenser had a 1/4 in. red lamp at the center of the top, and directly above it was mounted a second lamp, 5/8 in. in diameter. These served as signal lights and were controlled by switches located behind the panel as was the coin dispenser. The area of the cabinet directly beneath the coin slot was left clear for the child to place his rewards, out of his way but in plain view.

The subjects in each school were tested in a small, quiet, well lighted room within the school building. Each child was familiar with the room as well as with the sight of the experimenter who, he had been told, had brought a game for some of the children to play. The experimenter sat behind but to the side of the panel, still visible to the subject,and passed a board through the slot. The no-signal group was told that it was a pegboard game and to take the board and fit it into the hole. The subject was told to fill the board with pegs from the tray. He was told that when he finished he should pull the board out and pass it back through the slot at which time something would happen, sometimes a loud noise (coin dispenser), and sometimes the

same loud noise and a prize (dispensed coin). He was asked to take the nickel prize and to put it down on the table. He was told that every time he was given a new board he should start again. The signal group received the same instructions with the modification that if the little light was on there would only be a loud noise when he finished; if the big light was on there would be the same loud noise and a nickel prize would be given when he finished. Work with pilot subjects showed that it was necessary to insure that the subjects actually looked at the signal light. Subjects were instructed to start the next trial only after they saw the signal light. In practice the subjects were not paced by the light; it was turned on simultaneously with the dispensing of the board.

Subjects worked steadily, completing twenty trials. Between each trial the experimenter recorded the time and reset the timer, dispensed reinforcement, changed the signal light when appropriate, and provided a new board. After trial 20, the child was given an envelope in which to put his nickels and take them home.

Four analyses of variance were computed on the data for time to complete each trial. Only trials involving a change in reinforcement were used in these analyses: 1) The signal (S) group when trial n was not reinforced (0) and trial n + 1 was reinforced with a nickel (5) was compared to the no-signal (N) group when trial n was not reinforced (0) and trial n + 1 was reinforced (5); this comparison was S 0-5 vs. N 0-5. 2) Signal group with trial n reinforced and trial n + 1 not reinforced was compared to the no-signal group with trial n reinforced and trial n + 1 not reinforced; this comparison was S 5-0 vs. N 5-0. 3) The third comparison was S 0-5 vs. N 5-0. 4) The fourth com-

parison was S 5-0 vs. N 0-5. For the 20% reinforcement groups there were four trials on which a nickel was given and for the 80% groups there were four trials on which no nickel was given; for these two sets of groups the 0-5 and 5-0 trials were determined. For the 50% reinforcement groups there were ten reinforced and ten nonreinforced trials; the 0-5 and 5-0 trials used in the anlayses were randomly sampled from the first, second, third, and fourth sets of five-trial blocks. Each of the analyses, therefore, considered high-low SEL, signal-no signal, percentage of reinforcement, blocks 1, 2, 3, 4, and trial (n)-(n + 1). The trials corresponded to the 0 and 5 reinforcements. It should be noted that these four analyses are not completely independent, but they were chosen because of our interest in the relationship between trial n and trial n + 1. The no-signal groups were expected to show an effect of the reinforcement or nonreinforcement of trial n upon their performance on trial n + 1. The signal groups were expected to show an effect of the signal on the same trial in which the signal appeared. The question of interest was the relative effectiveness upon the high and low SEL subjects of a previous reinforcement or nonreinforcement and the signalled expectation of a subsequent reinforcement or nonreinforcement. The results of the study are shown in Figures 13 and 14. Figure 13 shows the mean time for completing the task for the high and

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low SEL children, with the 0-5 and 5-0 trials from each of the four blocks of five trials. The results are graphed for the three reinforcement percentages. Figure 14 depicts the difference in time for completing the task

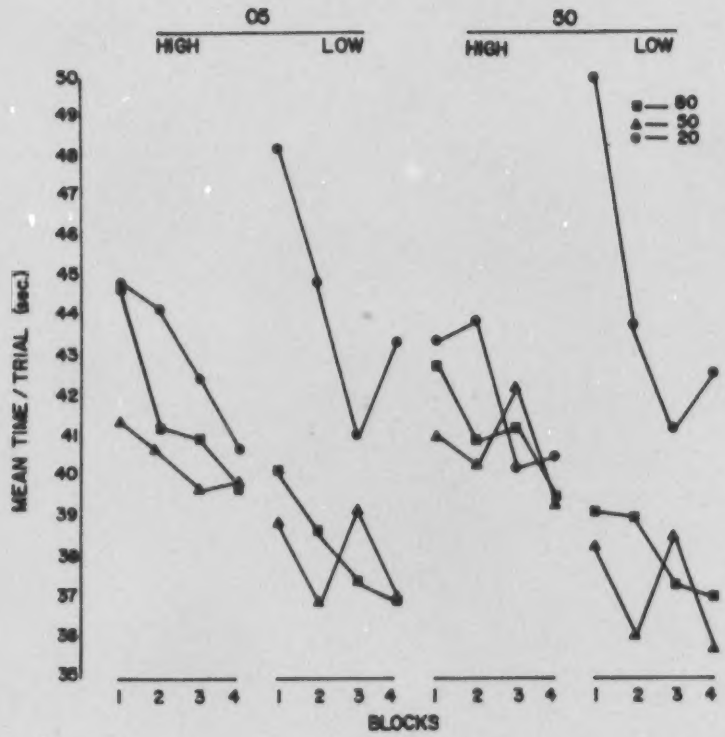

Figure 13. Mean time to complete task during a pair of trials (one reinforced and one nonreinforced) taken from each of the four blocks. The curves denote the performance of high and low SEL subjects with 80, 50, and 20 percent reinforcement.

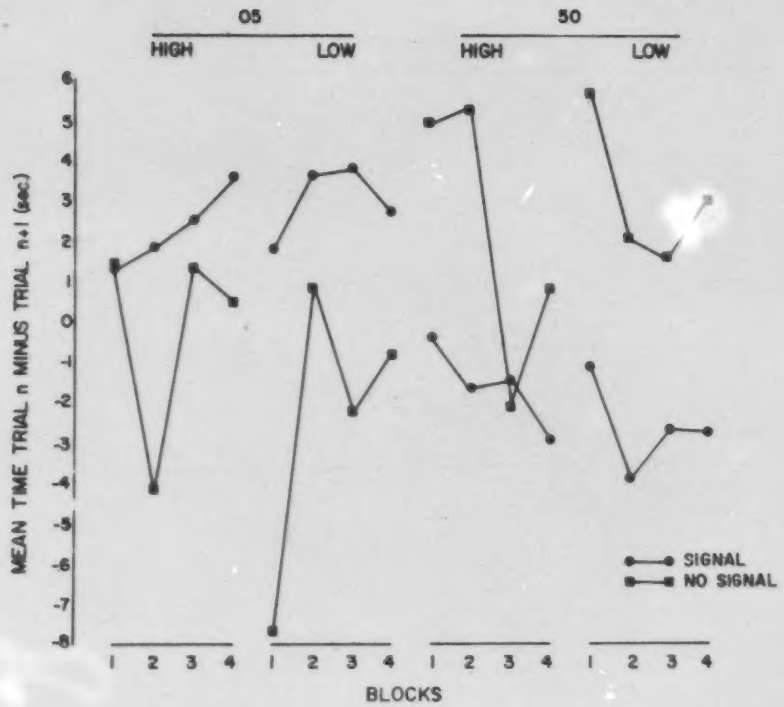

Figure 14. Mean difference in time to complete task during trial n and trial n + 1 of a pair of trials (one reinforced and one non-reinforced) taken from each of the four blocks. The curves denote the performance of high and low SEL subjects with signals and with no signals for reinforcement.

between trial n and trial n + 1 for the signal and no-signal groups as a function of SEL, 0-5 and 5-0 trials, and blocks of trials.

The mean time to complete the task decreased significantly over the four blocks of the session. In each of the four analyses the four blocks consisted of two trials (n and n + 1). The analyses compared trials n and n + 1 for the signal and no-signal conditions, S 0-5 vs. N 0-5 ($F = 7.019$, $df = 3/72$, $p < .01$), S 5-0 vs. N 5-0 ($F = 6.267$, $df = 3/72$, $p < .01$), S 0-5 vs. N 5-0 ($F = 6.1129$, $df = 3/72$, $p < .01$), and S 5-0 vs. N 0-5 ($F = 7.233$, $df = 3/72$, $p < .01$). Only for the S 5-0 vs. N 5-0 did the rate of decrease in time interact with the reinforcement schedules of 20, 50, and 80% ($F = 2.288$, $df = 6/72$, $p < .05$); the graph of this analysis provides no meaningful interpretation. In general, the decrease in task time over blocks was relatively homogeneous for both SEL groups, both signal and no-signal, both sexes, and all three reinforcement schedules. Furthermore, there were no significant main effects or interactions among these same variables, SEL, signal vs. no-signal, sex, and reinforcement schedule.

The difference between task time on trials n and n + 1 proved interesting. When trial n was a 0-reinforcement and trial n + 1 was a 5-reinforcement for both the signal and no-signal groups, S 0-5 vs. N 0-5, there was no significant difference between n and n + 1 but there was a significant interaction, signal vs. no-signal by n vs. n + 1 ($F = 10.042$, $df = 1/24$, $p < .01$). The graph shows that with a signal the task time decreased from a 0-reinforcement on trial n to a 5-reinforcement on trial n + 1. With a signal the response time was a function of the signalled (expected) reinforcement. The graph also shows that with no-signal the task time in-

creased from a 0-reinforcement on trial n to a 5-reinforcement on trial n + 1. With no signal the response time was a function of the previous reinforcement. These results were replicated in the comparison of S 5-0 and N 5-0. Task time increased from the signalled 5-reinforcement on trial n to the signalled 0-reinforcement on trial n + 1. Task time decreased from the unsignalled 5-reinforcement on trial n to the unsignalled 0-reinforcement on trial n + 1. The signal vs. no-signal by trial n vs. n + 1 was again significant ($F = 33.402$, $df = 1/24$, $p < .01$). The signal group was controlled by the signal for the next reinforcement and the no-signal group was controlled by the previous reinforcement. For the S 5-0 vs. N 5-0 analyses there was an additional interaction between reinforcement schedules and trials ($F = 4.433$, $df = 2/24$, $p < .05$). There is no meaningful description for this additional interaction.

Given the above conclusion it is to be expected that the S 0-5 vs. N 5-0 analysis should show a decrease in task time from trial n to trial n + 1 both for S 0-5 and N 5-0, i.e., a significant main effect of trial n vs. n + 1 and no interaction between signal vs. no-signal and trial n vs. n + 1. This was confirmed; the main effect of trials was significant ($F = 39.131$, $df = 1/24$, $p < .01$) and the interaction was not significant. Furthermore, it is to be expected that the S 5-0 vs. N 5-0 analysis should show an increase in task time from trial n to trial n + 1 for both S 5-0 and N 0-5. The increase was significant ($F = 7.854$, $df = 1/24$, $p < .01$) and there was no interaction between signal vs. no-signal and trial n vs. trial n + 1.

Over the four analyses there were five different significant ($p < .05$)

three or four way interactions involving blocks of trials, trials n and n + 1, and several of the between-subject variables of SEL, reinforcement schedule, and signal vs. no-signal. There were no replications of any of these five interactions and they are, therefore, of no particular interest.

Experiment VII yielded the expected results. There was a general decrease in response time over the session. The important finding was that the subjects were controlled by the anticipated reinforcement when reinforcements were signalled and the previous reinforcement when reinforcements were unsignalled. Perhaps unexpectedly there were no meaningful or consistent effects of SEL (or sex). The particular schedules of reinforcement, 80, 50, and 20% had occasional but weak effects.

Discussion of Reward Preferences

Experiment VI was designed to investigate choice responding for two reinforcement schedules which produced equal mean reward. Both high and low SEL subjects chose the schedule with the higher reinforcement probability and low reinforcement magnitude significantly more often; the proportion of such choices was significantly greater for the low SEL subjects than for the high SEL subjects. Furthermore, the low SEL subjects had considerably more tendency to retain a choice which had just previously been rewarded. Experiment VII was designed to investigate further the effects of a previous reinforcement or nonreinforcement. In Experiment VI the subject was confronted with a choice between two simultaneously presented response keys; in Experiment VII a single response was measured during successive trials. The results of Experiment VII showed that response time

was a function of the previous reinforcement or nonreinforcement, but that there was no interaction between the effects of the previous trial and SEL. Both high SEL and low SEL subjects took more time to complete the task on a trial following a nonreinforcement than on a trial following a reinforcement; the difference in the time taken to complete the task after reinforcement and nonreinforcement was not a function of SEL. Some groups in Experiment VII were given a discriminative stimuli which changed the paradigm from a mixed schedule to a multiple schedule. One signal was presented at the beginning of the trial if the response was to be reinforced on that trial and another stimulus was presented at the beginning of the trial if the response was not to be reinforced on that trial. For these groups, the time taken to complete the task was controlled by the signal (expected reward) rather than the previous reinforcement. The time taken to complete the task was shorter when a reinforcement was signalled than when a nonreinforcement was signalled. Again there was no interaction with SEL.

A general conclusion may be that high and low SEL children differ in their choice behavior when confronted simultaneously with two reinforcement schedules. However, high and low SEL children do not differ in their relative response rates as effected by successive reinforcements and nonreinforcements on either mixed or multiple schedules of reinforcement. Particularly interesting is the finding that low SEL subjects can use the discriminative stimuli of the mixed schedule as well as the high SEL subjects.

Response Rates, Instructions, and Training

The purpose of Experiment VIII was to determine some of the conditions of reinforcement which maintained high and low SEL responses. There were four related procedures. The results of each procedure led to the use of the next procedure. The purpose of the first procedure was to determine response rates for the two SEL groups without prior experimental training or instructionally produced expectations. The measure intentionally confounded activity rate with the ability to follow instructions. The finding of no significant difference in response rate between the two SEL groups provided a control condition for the subsequent manipulations. Two variables were of specific interest: expectations produced by instructions and expectations produced by prior training. The second procedure considered instructionally produced expectations; the subjects were told that there would sometimes be a consequence of their responses. These instructions were chosen for their ambiguity. The subsequent test phase employed continuous reinforcement for one-half of the subjects and extinction for one-half of the subjects. The third procedure considered behaviorally produced expectations; the subjects were given different periods of training prior to the test phase. The third procedure was then replicated. The pre-training in the third procedure employed continuous reinforcement for fixed durations. Although different expectations could have been produced by different schedules of partial reinforcement, the third procedure was chosen because it was the same procedure used for one-third of the subjects run under the first procedure, the control condition.

The purpose of the initial procedure was to compare response rates

for the two SEL groups without either prior experimental training or instructionally produced expectations. In another sense, the procedure can be viewed as a determination of activity rates confounded with the ability to follow instructions. This procedure constitutes the control condition for the ensuing experiments.

The subjects were 13 male and 11 female four-year old white children. All children were enrolled in a pre-school program. The high SEL subjects attended and were tested at private, tuition-supported nursery schools in Fulton County, Georgia. The low SEL subjects were enrolled in Headstart programs in Decatur, Georgia, and were tested within the school setting. The Headstart program is limited to children from families with less than a $3,000 annual income.

The front panel of the apparatus was a blue 18 in. square piece of 0.5 in. thick plywood set at a 30^{o} angle in a three-sided acoustical screen. A square hole, 6 x 6 in., in the center was covered by a 8 in. square sheet of clear plexiglass. A 6 in. square and 3 in. deep box was located behind the plexiglass sheet; it had a milk glass top and contained a two-way mirror inserted half way from the bottom of the box. A 15 W bulb was located above the mirror and a 60 W bulb was located below the mirror. A line drawing of a face was glued to the bottom inside of the box. One bulb illuminated only the inside of the seemingly empty box above the two-way mirror. The other bulb illuminated with equal intensity a box with a smiling face at the bottom.

Twenty-four subjects were tested individually for 15 min. Four subjects from each of the two SEL groups were assigned to one of the three

conditions: 1. panel press produced a counter noise, 2. press produced light and counter noise, and 3. press produced smiling face, light, and counter noise. All feedback was presented for approximately 0.25 sec. following each press. Instructions were given verbally with an accompanying demonstration immediately preceding testing. "In front of you there is a clear plastic plate (pointing). Press this plate as quickly and as often as you can (Experimenter presses plate four times in rapid succession). After each press, let your hand up slightly (Experimenter demonstrated holding subject's hand); the plate will also move up slightly, and then press the plate again. Press the plate as often as you can. I will tell you when to stop." Each press was counted as a response. Cumulative totals were recorded at one minute intervals.

The six mean cumulative response curves for the two SEL groups in each of the three procedures were all nearly linear, i.e., the slopes were constant.

The analysis of variance did not demonstrate a significant difference between the two SEL groups ($F = .02$, $df = 1/18$), the three conditions ($F = 2.78$, $df = 2/78$, $p > .05$), nor an interaction between SEL and conditions ($F = .18$, $df = 2/18$).

The purpose of the second procedure was to determine response rates for the two SEL groups with instructionally produced expectations.

Nine male and seven female subjects were drawn from the same populations used in the first procedure. The apparatus used was the same as used previously. The 16 subjects were tested individually for 15 min. Four subjects from each of the two SEL groups were assigned to one of the

two conditions. : 1. the smiling face never appeared, 2. the smiling face appeared for approximately 0.25 sec. after each press. Instructions were given verbally with an accompanying demonstration immediately preceding testing. "When you press the window (pointing) in front of you, a light will go on behind it (Experimenter presses window). Maybe you will see a smiling face like this one (Experimenter shows subject a line drawing of a smiling face). You probably won't be able to see it every time that you press the window. After you have pressed the window, let your hand up slightly and press the window again to make the light go on again. (Experimenter demonstrates, holding subject's hand). The light may show you the smiling face. You can see the face only if you press the window." The instructions were designed to produce an expectation of partial reinforcement.

The mean cumulative response curves for both SEL groups, who were told that they might see a smiling face sometimes and always saw it, were similar in their mean response rates. The high SEL curve was linear. The low SEL curve had a slight positive acceleration. With the same instructions but never seeing the smiling face, the high SEL mean cumulative response curve was linear again but the low SEL curve was negatively accelerated (See Figure 15).

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Insert Figure 15 about here
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An analysis of variance demonstrated significant effects of SEL, reinforcement contingency, and a SEL X reinforcement contingency interaction. The main effect of time (minutes) was statistically significant, as well as

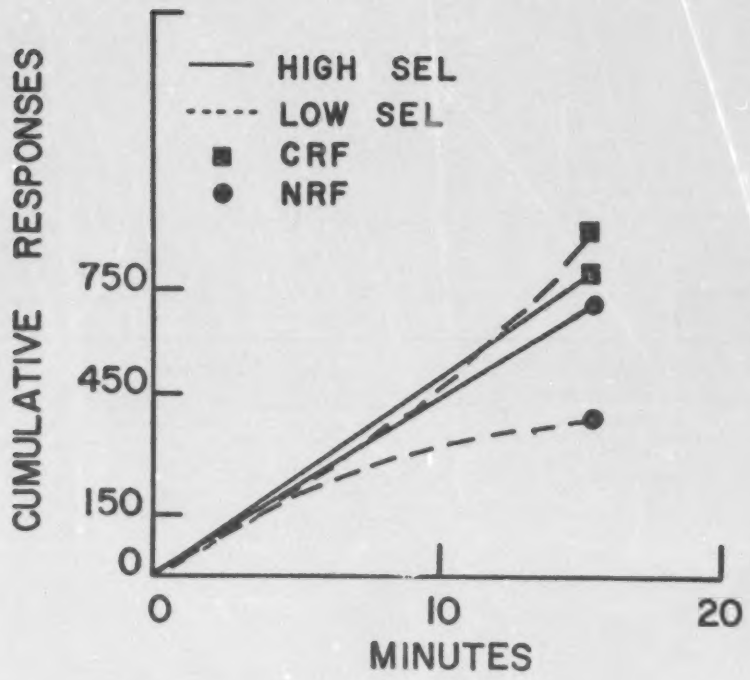

Figure 15. Mean number of cumulative responses for both high and low SEL groups with the instructionally produced expectation of partial reinforcement (PRF) and either with continuous reinforcement (CRF) or without reinforcement (NRF) in the first and second procedures of Experiment VIII.

the SEL X time interaction, reinforcement contingency X time interaction, and the triple interaction between time, SEL, and reinforcement contingency (see Table 9)

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Insert Table 9 about here
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The purpose of the third procedure was to create different expectations of reinforcement by training within the experimental setting as well as by instructions. The responses of the two SEL groups to subsequent nonreinforcement were the dependent measures.

The 11 male and 13 female subjects were drawn from the same populations used previously. The apparatus was the same as that used previously. Four subjects from each SEL were assigned to each of the three experimental conditions and tested individually: 1. smiling face available for five min., 2. face available ten min., 3. face available for fifteen min. Extinction immediately followed the continuous contingent presentation of the smiling face. Instructions were identical to those used in the second procedure and were given verbally with an accompanying demonstration immediately preceding testing. The extinction criterion was 2 min. without a response.

The mean totals of nonreinforced responses for the two SEL groups following the three different length sequences of continuous reinforcement are plotted in Figure 16. The number of nonreinforced responses is

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Insert Figure 16 about here
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a monotonic function of the length of the preceding continuous reinforcement

Table 9

Analysis of Variance: Experiment VIII, Second Procedure

Source	df	MS	F
SEL (A)	1	6594	2198.00*
Reinforcement Contingency (B)	1	25420	84.73*
Minutes (C)	14	830	20.75*
A X B	1	7958	2652.66*
A X C	14	284	7.10*
B X C	14	4130	103.25*
A X B X C	14	329	8.23

*$p < .01$

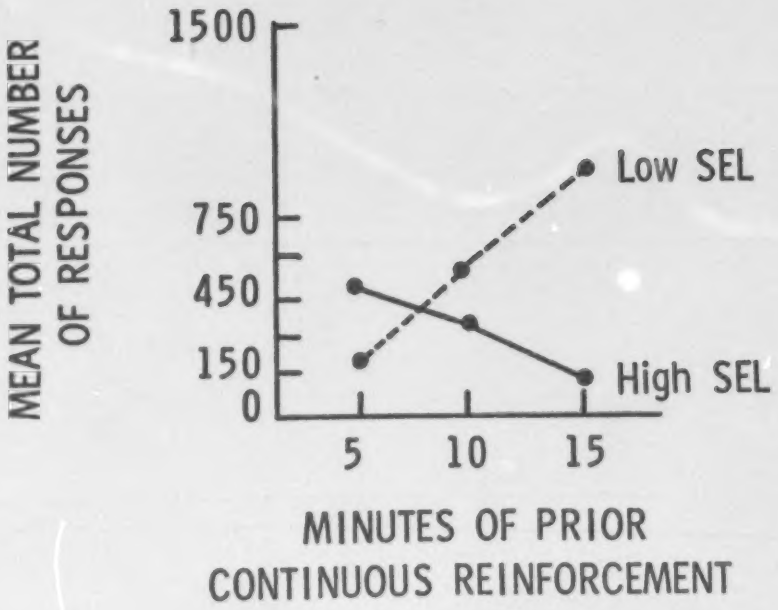

Figure 16. Mean number of responses to extinction for both high and low SEL groups following five, ten, and fifteen minute periods of continuous reinforcement in the first replication of the third procedure of Experiment VIII.

sequence. For the low SEL subjects the function is a positive monotone. For the high SEL subjects the function is a negative monotone.

The analysis of variance indicated a significant effect of SEL, prior reinforcement, and a SEL X prior reinforcement interaction (see Table 10).

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Insert Table 10 about here
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The results of the third procedure were of sufficient interest to warrant running a replication with a larger number of subjects included in each of the conditions; eight subjects from each SEL were assigned to each of the three procedures. Only male subjects were run to control for sex.

The subjects were 48 Junior First Grade and kindergarten white males between five and one-half and six and one-half years old. Junior First Grade is a program with standards similar to those of Headstart. The 24 low SEL subjects were enrolled in the Decatur, Georgia, Junior First Grade program. The 24 high SEL subjects were enrolled in private, tuition supported nursery schools. None of the high SEL subjects had been placed in the nursery school to allow his parents to work.

The apparatus was functionally similar to that used previously. However, instead of mounting it behind a large slanted panel, it was placed inside a square metal box. All mechanical parts such as relays were replaced by solid state components. Responses were recorded on an event marker in a sound proof box. Three sided screens of acoustical tile isolated each subject from his surroundings. The procedure was identical to

Table 10

Analysis of Variance: Experiment VIII, Third Procedure

Source	df	MS	F
SEL (A)	1	273066	200.93*
Prior reinforcement sequence (B)	2	114104	83.96*
A X B	2	153157	112.69*

*$p < .01$

that used previously except that four subjects were tested at a time. Instructions were given individually and immediately preceding testing.

Figure 17 represents the mean totals of nonreinforced responses of the two SEL groups following the three different length periods of continuous reinforcement. As demonstrated previously, the number of nonreinforced responses was a negative monotonic function of the length of the preceding period of continuous reinforcement for the high SEL group and a positive monotonic function for the low SEL group. Since the responses of the low SEL group were extinguished after six min. of nonreinforcement following five min. of continuous reinforcement, the number of responses for each of the groups during this six-min. period were considered (Figure 17b). A noncumulative minute by minute graphic analysis of the number of nonreinforced responses made within each of the minutes (following the three different length periods of continuous reinforcemnt) for both groups demonstrated the temporal development of the phenomenon (Figure 18).

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Insert Figures 17 and 18 about here
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The analysis of variance demonstrated an effect of SEL, prior reinforcement, and time in one-min. blocks. There were significant interactions for SEL X prior reinforcement, SEL X time, and time X prior reinforcement. The triple interaction was also significant (see Table 11).

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Insert Table 11 about here
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Holland (1958) demonstrated that, "The rate of observing an instrument is controlled by the schedule of signal detections." His procedure

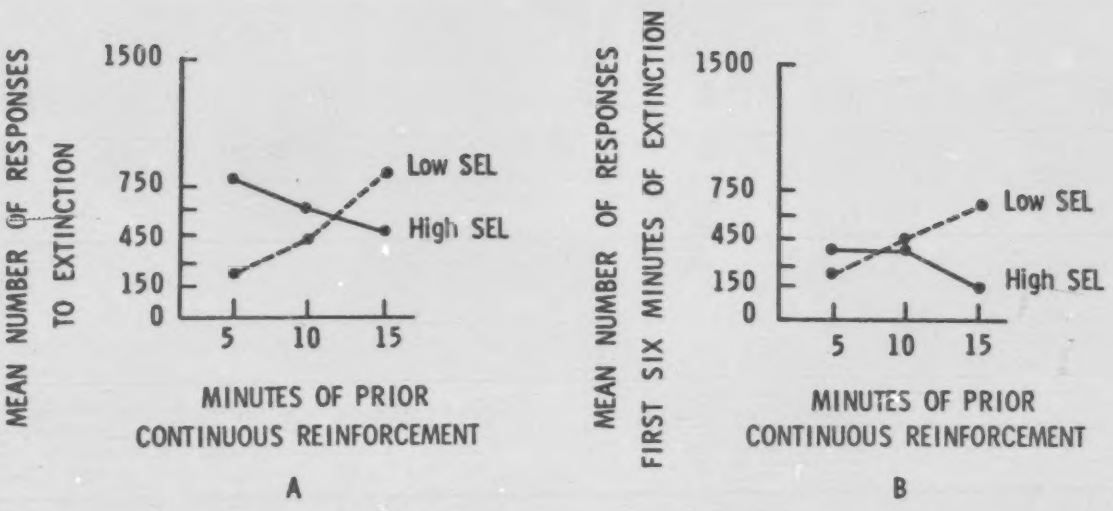

Figure 17a. Mean number of responses to extinction for both high and low SEL groups following five, ten, and fifteen minute periods of continuous reinforcement in the first replication of the third procedure of Experiment VIII.

Figure 17b. Mean number of responses made during the first six minutes for both high and low SEL groups following five, ten, and fifteen minute periods of continuous reinforcement in the first replication of the third procedure of Experiment VIII.

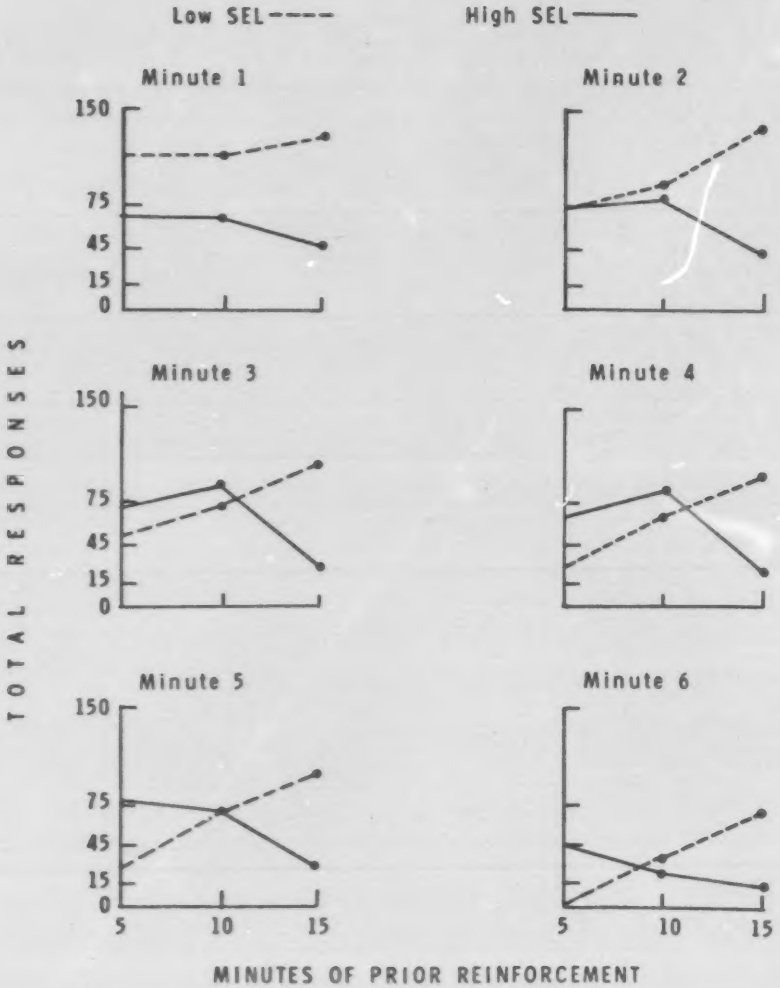

Figure 18. Mean number of responses made during each of the first six minutes for both high and low SEL groups following five, ten, and fifteen minute periods of continuous reinforcement in the second replication of the third procedure of Experiment VIII.

Table 11

Analysis of Variance: Experiment VIII, Replication of Third Procedure

Source	df	MS	F
SEL (A)	1	37355	106.73*
Prior reinforcement sequence (B)	2	7806	22.34*
Minutes (C)	5	23435	120.79*
A X B	2	59831	170.93*
A X C	5	3341	17.22*
B X C	10	890	4.59*
A X B X C	10	1477	7.67*

*$p < .01$

required a report of all detections. Frankmann and Adams (1962) suggested that a procedure without detection reports would limit the stimulus control found by Holland. They hypothesized that two responses occurred. The first response made a detection possible by making the display visible and the rate of this response was controlled by subject variables. The second response was a sense receptor orientation and its rate was controlled by the schedule of signals. The instructions in the first procedure emphasized the first response of making the display visible without any mention of the importance of the feedback. The task and instructions were simple and both SEL groups were able to perform equally well. No reinforcement contingencies were mentioned; and, therefore, there were presumably no explicit expectancies of a specific reinforcement.

The second procedure was the "zero" condition for the third procedure. The same instructions were used in these experiments. They differed primarily in that the second procedure employed zero minutes of experimental training and the third procedure employed 5, 10, and 15 minutes of training. There was a discontinuity in the results from the zero training to the 5, 10, and 15 minute training conditions when the results were plotted on comparable scales. The low SEL group made fewer responses in the second procedure than the high SEL group. In this experiment the low SEL group behaved more pragmatically. The subjects had been told that they would sometimes see a face. When no faces appeared the low SEL subjects soon stopped responding. This situation was most likely a very familiar one for them. However, the low SEL behavior became relatively less pragmatic compared with the high SEL as the length of training increased.

The performance of the two SEL groups differed only when a discrimination between successive reinforcement contingencies could be made in the third procedure. The low SEL responding was apparently based on the number of times the response had been reinforced. The high SEL group appeared to be better able to distinguish between reinforcing and nonreinforcing situations than was the low SEL group. In the second procedure the ability to distinguish different situations was not relevant since there was only continuous reinforcement or continuous nonreinforcement. There was no significant difference in performance between the two SEL groups in the first procedure and for the continuous reinforcement groups of the second procedure. The reinforcement was consistent and unchanging. The expectation of reinforcement for both SEL groups seemed to be based primarily on the number of reinforcements in the test situation. There was a significant difference between the two SEL groups when no experimentally controlled reinforcement followed a response in the second procedure. The low SEL response extinguished; it had never been followed by reinforcement in the test situation. The high SEL response did not extinguish within the test period; reinforcement had been described as forthcoming within the test situation but there was no reinforcement shift (contrast) in the situation.

The data in the two replications of the third procedure further demonstrated that high SEL compared with low SEL responses were more affected by changes in successive reinforcement contingencies. The two replications produced the same results. Assume that high SEL children reacted to the change in the reinforcement contingency between acquisition and extinction procedures. Then it follows that the longer acquisition periods made these

changes more obvious and the reaction of the high SEL children was more immediate following the longer acquisition periods. Assume that the low SEL group responded on the basis of the number of reinforcements. Then it follows that they stopped responding more quickly following the shorter acquisition periods.

The third procedure of Experiment VIII was an investigation of the effect of training upon instructed responding during extinction. Experiment IX was designed to study further the potential control of behavior by instructions. In Experiment IX responding to stimuli which had been associated with reinforcement was compared to responding to stimuli which had been specified in verbal instructions to the subject. The research was focused on factors that may establish stimulus control of motor behavior by instructions and permitted a comparison of the relative control of responding by instructed and by trained stimuli.

Because age was considered to be the most potent subject variable, 8 three-year old and 8 five-year old white boys were selected for the first procedure in Experiment IX.

The subjects were enrolled and tested at private nursery schools in the Atlanta, Georgia, area. They came from intact homes with the father being the primary wage earner in a skilled to professional occupation (range of family income was $9,300 - $37,000). The range of family size was one to six children. The birth order of subjects was unsystematic. The parents of all subjects were born within the continental United States and predominantly within the southeastern region.

All subjects were tested to determine if they could name and select color stimuli (red/green/blue/yellow/white - Benjamin Moore paint color

samples). The stimuli were presented to the subject one at a time and he was asked to name the color; then, he was given a color name, e.g., "red" and was asked to select the color sample from all five stimuli. The colors were presented in an unsystematic order. There were ten trials for each color both in the naming and in the selecting tasks. The ability to respond correctly to color stimuli and names was important because subjects subsequently were instructed to respond to specific colors on the experimental tasks. Only subjects who had this ability were used in the first procedure of Experiment IX.

A four in. square rear-projection screen was mounted on a 24 in. square slanted panel over a central opening. The screen was covered by a clear plastic "window." The window was the manipulandum. Pressing the window closed a microswitch. A movie projector with a movie cartoon film loop was mounted behind the rear-projection screen. When appropriate, the projector ran continuously. Pressing the window turned on the projection lamp for two seconds allowing a two-second movie cartoon presentation. Colored lights (red/green/blue/yellow/white) backlighted the projection screen and functioned as discriminative stimuli. Responding in the presence of a positive discriminative stimulus turned off the discriminative stimulus light and turned on the projection lamp for two seconds. Pressing the window in the presence of each of the discriminative stimuli (colored lights) advanced a different unit counter. The presentation of discriminative stimuli and the scheduling of potential consequent stimuli were automatically controlled by a combination of mechanical and solid state devices. The devices were isolated in a sound insulated box. To summarize, the colored lights functioned as discriminative stimuli, pressing the window covering the rear-

projection screen was the response, and a short movie cartoon presentation was the consequent stimulus.

In the first procedure of Experiment IX the subjects received verbal instruction about the consequence of responding in the presence of a specified stimulus (instructed stimulus). Each subject was told, "When the window is (color), press the window (experimenter pointing) and you will see a cartoon then (experimenter stops pointing)." Color stimuli and cartoons were not presented and the subject was not given any opportunity to respond during the instruction. Immediately following the instruction, the subject received cartoons for responding to a stimulus color (trained stimulus) different from the instructed stimulus. The trained stimulus was presented at a variable interstimulus interval for 15 sec. every minute for 15 min. Responding in the presence of the trained stimulus was followed by a 2-sec. cartoon presentation. Responses during the other 45 sec. of each minute were not reinforced. No other stimuli were presented during this training phase. Immediately after training the subject was tested on the instructed stimulus, the trained stimulus, and a novel stimulus. The stimuli were presented for 15 sec. each with variable interstimulus intervals and in an unsystematic order. Blank intervals separated the stimulus presentations. No reinforcements were presented during the 15-min. test period. The results during the test were dramatic. All three-year old subjects responded more to the trained stimulus than to the instructed stimulus and all five-year old subjects responded more to the instructed stimulus than to the trained stimulus. The significant Age X Stimulus interaction ($F = 57.34$, $df = 2/28$, $p < .01$) can be seen in the response means

for trained, instructed, and novel stimuli shown in Table 12. The interaction is graphed in Figure 19 for responses to the trained and instructed stimuli.

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Insert Table 12 about here
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Insert Figure 19 about here
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The question then became one of discovering ways of inducing the behavior of five-year old subjects in three-year old subjects. That is, could one make three-year old boys act like five-year old boys? A frequently available answer in the developmental psychology literature is that three-year old subjects are not at an appropriate stage in their development. We chose to assume that child behavior is not a function of developmental stages but that training sets the stage for child behavior. The second procedure of Experiment IX was designed to investigate the role of verbal pretraining upon the relative responding to trained and instructed stimuli.

The second procedure was employed with three-year old subjects who had failed to display an ability to respond correctly to color stimuli and names. Four different pretraining conditions were used with eight subjects in each of four groups. Following the pretraining each group was run through the entire first procedure. The addition of the pretraining phase was the only difference between the treatment of these four groups of subjects and the previous group of three-year old subjects. At the start of the verbal label pretraining procedure, each subject was told color names and asked to repeat the names. This allowed the experimenter to determine each child's distinctive pronunciation and to give a practice

Table 12

Mean Number of Responses to Each Stimulus in the Test Phase of the First Procedure of Experiment IX

	Stimulus		
	Trained	Instructed	Novel
3 year olds	59.37	33.25	27.88
5 year olds	38.38	86.00	35.00

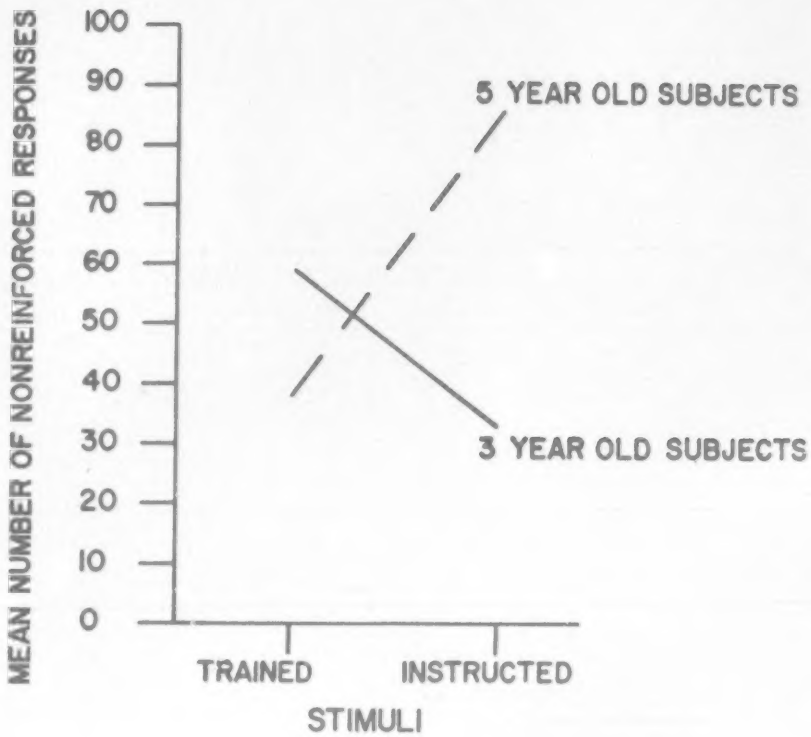

Figure 19. A comparison of the responding by three- and five-year old subjects to instructed and trained stimuli. The subjects were tested in extinction after being instructed to respond to one stimulus and then receiving reinforcement for responding to another stimulus (the first procedure of Experiment IX).

response trial. Next, the child was shown a colored window, told the color name, and asked to repeat that color name; this was done for two colors. Immediately following this demonstration, the two stimulus colors were presented in an unsystematic order until the subject had correctly named each of the stimuli on 20 trials. A correct naming of the stimulus was followed by a 0.5-sec. brightening of the stimulus; no change followed an incorrect naming and the trial continued until the color was named correctly. The four verbal training conditions were 1) systematic-relevant training in which the correct names were required and the stimuli were the same two colors that were later used as instructed and trained stimuli, 2) systematic-irrelevant training in which the correct names were required but the stimuli were two that were different from the subsequent instructed and trained stimuli, 3) unsystematic-relevant in which the correct and incorrect names were unsystematically required to terminate a trial, the naming being done with the same two stimuli that were later to be instructed and trained, and 4) unsystematic-irrelevant in which the correct and incorrect names were unsystematically required, the naming being done with two stimuli different from those used for later instruction and training. These four training conditions were immediately followed by the instructions, training, and testing used in the first procedure of Experiment IX. The results of the testing phase are shown in the top portion of Table 13. The mean number of responses to the instructed and trained stimuli are shown in Figure 20. It is clear that none of these conditions produced the higher response rates

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Insert Table 13 about here
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Table 13

Mean Number of Responses to Each Stimulus in the Test Phase of the Second and Third Procedures of Experiment IX

Pretraining Condition			Stimulus		
			Trained	Instructed	Novel
Verbal Labeling Pretraining	Systematic Reinforcement	Relevant Stimuli	55.50	25.00	27.00
		Irrelevant Stimuli	50.25	46.50	44.75
	Unsystematic Reinforcement	Relevant Stimuli	57.38	52.00	51.88
		Irrelevant Stimuli	50.75	52.00	50.12
Reinforcement Contingency Pretraining	Unsystematic Feedback		64.88	47.62	39.12
	Noninstructed Feedback		64.50	33.38	34.75
	Instructed Feedback		78.25	94.00	29.00
	Reward and Punishment		34.62	58.00	30.00

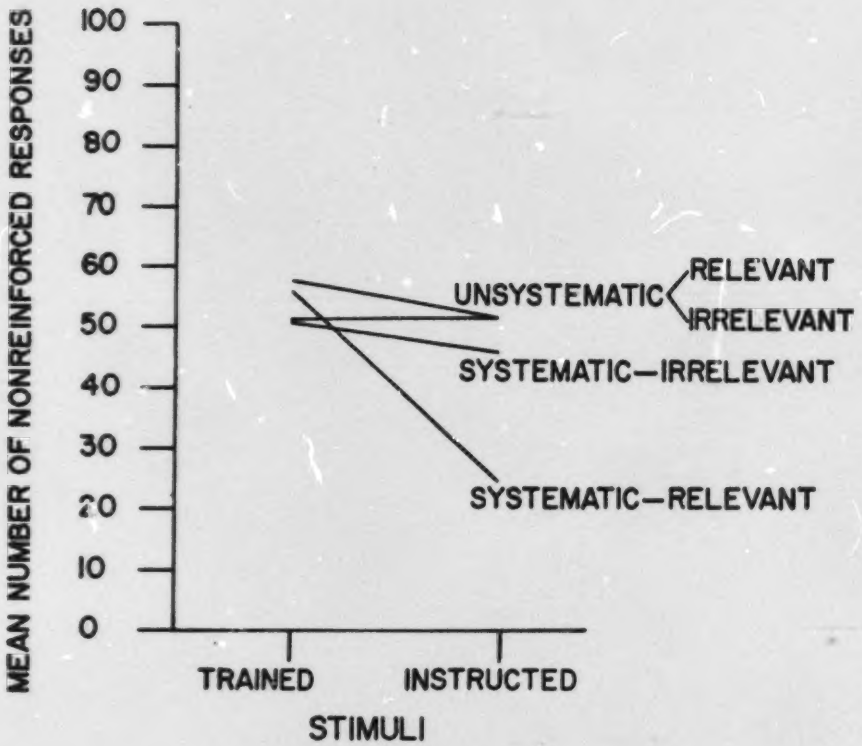

Figure 20. A comparison of the responding by three-year old subjects to instructed and trained stimuli after pretraining on verbal labeling of colors. The pretraining was on the same colors used in testing (relevant) or on different colors (irrelevant) with the correct color names taught (systematic) or with inconsistent color names taught (unsystematic). These conditions were the second set of procedures in Experiment IX.

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Insert Figure 20 about here
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for the instructed stimulus that were typical of five-year old subjects. The systematic relevant condition resulted in the same behavior we saw in the three-year old subjects of the first procedure. The other three conditions generated indiscriminate responding on the instructed and trained stimuli.

The third set of conditions were designed to test the other obvious hypothesis concerning the generation of the previously observed differences between three-year old and five-year old boys. The third procedure was an attempt to train three-year old subjects to follow instructions. Four groups of eight subjects each were sampled from the same population of three-year old boys; unlike the subjects in the second procedure, the subjects in the third procedure were sampled from those subjects in the population who could correctly name colors prior to the beginning of the experiment. In these reinforcement pretraining conditions, subjects who could name and select stimulus colors to the criterion of ten correct trials in a row were given instructions every minute for 20 min. Every minute the subject was told the color of the window and asked to press the window. The color changed with each instruction. For the remainder of each 1-min. interval the instructed color and three other colors were presented for 15-sec. each during which the subject was allowed to press the window. The four pretraining conditions were defined by the reinforcement contingency in effect during these intervals: 1) the unsystematic feedback group received a 0.1-sec. flash of light with a probability of 0.25 following re-

sponding to any of the four stimuli in each minute 2) the noninstructed feedback group received a 0.1-sec. flash of light with a probability of 0.33 following responding to any of the three noninstructed stimuli in each minute, but never received a flash of light for responding to the instructed stimulus of that minute, 3) the instructed feedback group always received the light flash following responses to the instructed stimulus but never received the light flash following responses to the three noninstructed stimuli in each minute, 4) the reward and punishment group received a two stage training sequence during the 15 min. first stage, responses to the instructed stimulus of each minute were followed by 2-sec. cartoon presentations; during the 5-min. second stage, responses to the instructed stimulus were followed by the cartoon and responses to one noninstructed stimulus (which had been the instructed stimulus of the previous minute) were followed by a blackout of the window while responses to the other two noninstructed stimuli had no consequence.

Following the pretraining, these four groups received the same instructions, training, and testing used in the first two precodures. The mean number of responses to the test stimuli are shown in the bottom portion of Table 13. The responses to the instructed and trained stimuli are graphed in Figure 21. It is clear from the graph that both the instructed

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Insert Figure 21 about here
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feedback group and the reward-and-punishment group exhibited the behavior that had previously been seen only with five-year old subjects. These two groups of three-year old boys responded more to the instructed stimulus than to the trained stimulus during testing. They had been pretrained to follow

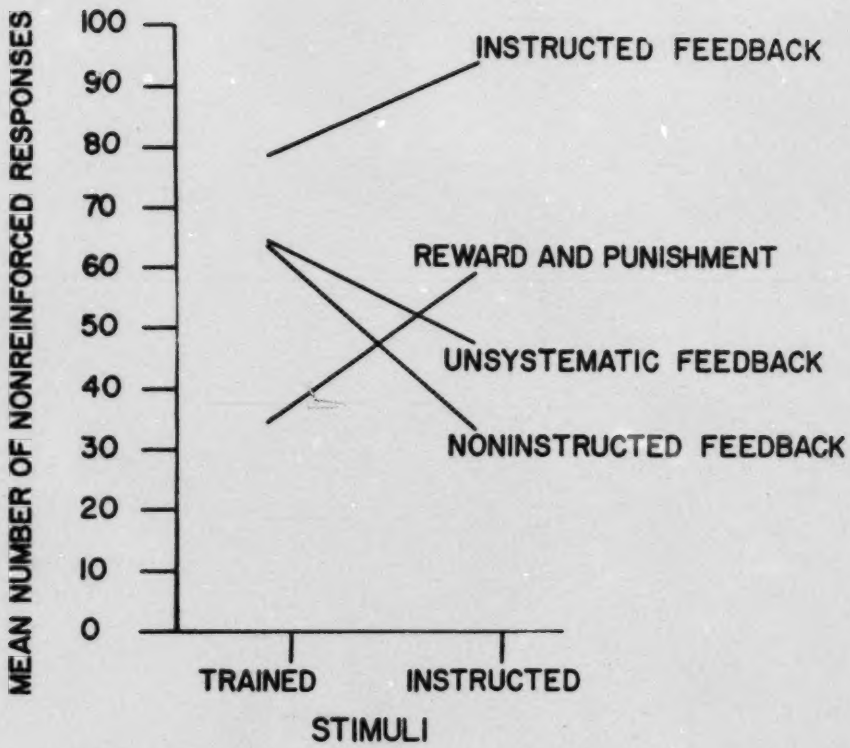

Figure 21. A comparison of the responding by three-year old subjects to instructed and trained stimuli after pretraining on following instructions. These four reinforcement conditions constitute the third set of procedures in Experiment IX.

instructions.

The differences among the pretraining groups were significant ($F = 3.88$, $df = 3/56$, $p < .05$) as well as the interaction betwe n pretraining conditions and responding to the two test stimuli ($F = 11.69$, $df = 6/56$, $p < .01$). It is clear from Figure 21 that the reward and punishment conditica suppressed overall responding below the response rate of the instructed feedback condition. The results showed that feedback for following instructions was sufficient for the production of a higher response rate to the instructed stimulus than to the trained stimulus. Actual reward and punishment is not only unnecessary but also has the possibly undesirable effect of reducing the number of responses to both stimuli.

Discussion of Response Rates, Instructions, and Training

The results of Experiment VIII showed that high and low SEL children followed simple instructions to respond to a single manipulandum. If reinforcement was promised but not delivered, the low SEL children soon stopped responding. If pretraining with continuous reinforcement was given prior to testing, the low SEL children approached and exceeded the responses of the high SEL children, as the amount of pretraining was increased.

The results of Experiment IX showed that the responses of younger children were controlled more by stimuli that had been associated with reinforcement whereas the responses of somewhat older children were controlled more by stimuli to which they had been instructed to respond. If pretraining in which responses to instructed stimuli were reinforced was given first, then the responses of younger children were also controlled more by instructed stimuli.

Both Experiments VIII and IX reflected attempts to recreate in one group

a behavior that had been found in another group. The attempt succeeded in Experiment IX but notin Experiment VIII. Or, put differently, the attempt succeeded too well in Experiment VIII; the low SEL children responded too much in comparison with the high SEL children who also had been given extensive pretraining. There are a great many possible interpretations of this discrepancy. There are so many interpretations that we are hesitant to even try to evaluate the alternatives. Nevertheless, one consideration is consonant with all the previous findings. Although younger children are untrained, low SEL children are trained but mistrained. The pretraining we used with the younger children made them act like older children; the pretraining we used with the low SEL children made them perseverate. This perseveration will be the principal topic of our summary and conclusions.

Summary and Conclusions

Our task now is to attempt to extract an overall pattern from the results of the nine experiments. Consider briefly the conclusions from each of the three main sections.

In concept acquisition low SEL children do not adopt the win-stay lose-shift strategy employed by adults and high SEL children. Low SEL subjects perseverate on an incorrect hypothesis when the rate of partial reinforcement is sufficiently high and when that hypothesis has been greatly overlearned (or high on their hierarchy).

In reward preference studies low SEL subjects chose consistency more often than high SEL subjects did. Low SEL children also displayed a greater tendency to retain a choice which had been reinforced just previously; high SEL children were more likely to shift away from a choice following reinforce-

ment. When successive reinforcements were externally signalled high and low SEL subjects were equally able to choose on the basis of the information provided.

In the last set of studies response rates were measured during extinction and after instructions and training had been manipulated. When reinforcement was unpromised and undelivered high and low SEL subjects responded equally. Low SEL children exhibited much faster extinction than high SEL children when reinforcement was promised but not delivered. Low SEL children exhibited much slower extinction than high SEL children after reinforcement was promised and delivered, if there was sufficiently long reinforcement training prior to the ultimate withdrawal of reinforcement.

It is important to note that these differences between the behavior of high and low SEL subjects are not always instances of the high SEL children doing "better" than the low SEL children. Some of the differences are favorable to the low SEL children, e.g., the low SEL children stopped responding when the promised reinforcements were not forthcoming. Our discussion shall dwell on differences and manipulations of these differences, not on value judgments.

In concept acquisition low SEL subjects do not adopt a win-stay lose-shift strategy. Randomly sampled subjects who are shifted to partial reinforcement after overlearning a discrimination do not adopt the strategy. In both cases, the subjects utilize the win-stay aspect of the strategy but do not employ the lose-shift component; they retain the partially reinforced behavior. Looking at another aspect of their behavior, low SEL subjects often learn a concept more slowly than high SEL subjects. After a relatively small number of random reinforcements, high SEL subjects learn as slowly as

low SEL subjects. In each of these experiments the subjects perseverated on a partially reinforced behavior. In a situation in which reinforcement is continuously available for some other behavior, this perseveration is clearly disadvantageous; in a situation in which no such other behavior exists, this perseveration is conversely advantageous. The subject's task is to discriminate among the possible contingencies. He must determine whether he is faced with a concept acquisition task, a simple discrimination problem, a probability learning task, extinction, an unsolvable (random) problem, etc. Certainly no one suggests that a subject typically does this in an orderly verbalized manner but, nevertheless, his task is to match his behavior to the contingency. A subject is most capable of conforming to those contingencies with which he has had the most recent experience or the most extensive experience. Subjects who have overlearned on one contingency do not readily shift their behavior when the contingency, or the nature of the task, is shifted. They perseverate on the old behavior.

Considering the data from the reward preference studies, the low SEL children tend to perseverate more on a previously reinforced response whereas the high SEL children display more shifting of responses. The task is one on which only the pattern of reinforcements, but not the expected number of reinforcements, is contingent on the choice behavior. There is no "correct" or "better" strategy and yet the low SEL children exhibit highly stereotyped response patterns. Considering the data from the mixed and multiple schedules of reinforcement, the two groups show no difference in performance. On the mixed schedule in which no discriminative stimulus is available, response times are a function of the previous reinforcement. On the multiple schedule in which discriminative stimuli are available, response times are a function

of the expected reinforcement. Both groups of subjects appear equally capable of determining the nature of these particular contingencies. In both these cases there were no choices to be made; the dependent variable was the time required to complete the task on each trial. These procedures were probabily less sensitive to differences between SEL groups.

Considering the data from the experimental procedures which tested the response rates in extinction, we find that the low SEL subjects do not perseverate on a response for which a reinforcement was promised but undelivered. When reinforcement is promised and actually delivered prior to its subsequent withdrawal, we see opposite effects upon the behavior of the high and low SEL groups. The longer continuous reinforcement is maintained prior to withdrawal, the faster the high SEL subjects exhibit extinction of the response and the slower the low SEL subjects exhibit extinction. The low SEL subjects perseverate on the previously reinforced response

We have attempted several training procedures which were designed to encourage response shifting. None of these procedures has proven to be completely satisfactory. In one of these procedures run by William Blum the subjects were given four successive discrimination problems before being tested on a concept acquisition task. The discriminations were all solvable for one group, all unsolvable for another group, and contained various combinations of solvable and insolvable discriminations for several other groups. The results of the experiment were somewhat encouraging but not readily interpretable because of the apparently complex sequence effects. We are now engaged in a much larger investigation of the transfer of learning effects in long sequences of successive learning tasks which require shifting response strategies.

In another one of the procedures which Joan Tritschler has already employed, subjects were allowed to choose between two equally reinforced alternatives. After the choice behavior had become stereotyped, reinforcement was made contingent upon the subject's shifting responses. The equipment was programmed so that only more complex patterns of choice behavior were reinforced. All subjects adopted the more complex patterns which had been used by the high SEL subjects in our previous experiment on reward preferences. The question of how this training would transfer to new situations requires extensive further investigation. We now have begun to design such procedures and to run pilot subjects.

We also considered the possibility that differences in response strategies might best be investigated as a function of personality variables rather than as a function of SEL. This approach was prompted by the concepts of internal and external control which had been proposed by Rotter (1966). External control was defined by Rotter in the following manner: "When a reinforcement is perceived by the subject as following some action of his own, but not being entirely contingent upon his action, it is typically perceived as the result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexities of the forces surrounding him." Conversely internal control was defined as, "When a person perceives that an event is contingent upon his own behavior, or his own permanent characteristics . . .." The possible relationship to our findings is almost inescapable. Mary McNair with the help of Russel Penrod, conducted an extensive study of the 89 fourth-grade students at Sagamore Elementary School, DeKalb County, Georgia. This school is in a

uniformly upper middle SEL neighborhood. Measures on the following tests were obtained from each subject: 1) Bialer Locus of Control Scale (Bialer, 1960), 2) Level of Aspiration Board (Rotter, 1942), 3) the reward preference procedure using the 25% and 100% choices described in Experiment VI of this report, 4) Otis Lennon Mental Ability Test, Elementary II Level, Form J, 5) Stanford Achievement Test, Intermediate I Level, Form W, and 6) the Adjective Check List (Gough and Heilbrun, Consulting Psychologists Press) filled out by each teacher. Considering all subtest scores, the alternative scoring techniques of the behavioral data, several composite test score differences, and subject categories such as sex and age, a 43 variable correlation matrix was obtained. The results were unfortunately not very informative. Locus of Control correlated significantly ($r = 0.2437$) with the Achievement Scale of the Adjective Check List. A dependent variable, defined the difference between the Otis Lennon I.Q. score and the Stanford Achievement Test score, was significantly correlated with the Defensiveness ($r = -0.3354$), Self-control ($r = -0.3777$), Achievement ($r = -0.3246$), and Succorance ($r = 0.2668$) Scales of the Adjective Check List. Performance on the two behavioral tasks, reward preference and Level of Aspiration Board, correlated with nothing. We have no plans for further investigations of this type.

We are pursuing the search for procedures with which to manipulate learning strategies. The goal is to design training techniques that teach specific learning strategies without producing perseveration on one strategy.

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Achievement Test Scores in Children from Different Socioeconomic Levels

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The purpose of this study was to investigate the distribution of changes in performance on a standardized achievement test. The subjects were sampled from higher and lower socioeconomic levels (SEL). At the beginning of the study, the subjects were in the second, fourth, and sixth grades of the Cobb County, Georgia, School System. The tests were administered in the Fall of 1968, the Spring of 1969, and the Fall of 1969. These tests permitted the consideration of changes in performance during the academic year and over the Summer recess.

Judith Grether and Donald P. Hayes have presented evidence in a paper entitled "Academic achievement, home background and the school--another dimension of the dilemma" that (1) white, non-white, high SEL and low SEL children all gain approximately the same amount from Fall to Spring on an achievement test, and (2) non-white pupils regress during the Summer while white pupils tend to maintain their Spring level of performance. Several problems in the interpretation of these results are presented by the authors. Their study was conducted cross-sectionally rather than longitudinally; the non-white group included students of Puerto Rican descent who might come from non-English speaking homes; the administration of the tests were in many cases questionable; there is great pressure on the New York City school teachers to demonstrate achievement for low SEL children. Their conclusions therefore warranted an attempt to longitudinally investigate the problem under

more controlled conditions with a more specifiable subject population. The Cobb County, Georgia, School System was particularly well suited for this study because of its relatively nontransient student body, wide socioeconomic diversity, and almost uniformly white population.

The high SEL subjects were sampled from Brumby, Hollydale, and East Valley Elementary Schools. The low SEL subjects were sampled from Fitzhugh Lee, Austell, and Hawthorne Elementary Schools. These schools from which the low SEL subjects were sampled are in census tracts for which the non-white population is 3.89% of the total population and the non-white housing units comprise 2.94% of the total number of housing units, based on an April 1, 1968, estimate by the Bureau of the Census. Race will not be considered as a variable in the analyses of the test results.

The Stanford Achievement Test consists of the following batteries:

Primary I:	Word Reading	Spelling
	Paragraph Meaning	Word Study Skills
	Vocabulary	Arithmetic
Primary II:	Word Meaning	Spelling
	Paragraph Meaning	Word Study Skills
	Science and Social Studies Concepts	Language
		Arithmetic Computation
		Arithmetic Concepts
Intermediate I:	Word Meaning	Arithmetic Computation
	Paragraph Meaning	Arithmetic Concepts
	Spelling	Arithmetic Applications
	Word Study Skills	Social Studies
	Language	Science
Intermediate II:	Word Meaning	Arithmetic Computations
	Paragraph Meaning	Arithmetic Concepts
	Spelling	Arithmetic Applications
	Language	Social Studies
		Science

Advanced:	Paragraph Meaning	Arithmetic Concepts
	Spelling	Arithmetic Applications
	Language	Social Studies
	Arithmetic Computation	Science

The three grade groups were given the following tests:

Grade 2 - November, 1968 - Primary I, Form W

Grade 2 - April, 1969 - Primary II, Form X

Grade 3 - November, 1969 - Primary II, Form Y

Grade 4 - November, 1968 - Intermediate I, Form W

Grade 4 - April, 1969 - Intermediate I, Form X

Grade 5 - November, 1969 - Intermediate I, Form Y

Grade 6 - November, 1968 - Intermediate II, Form W

Grade 6 - April, 1969 - Intermediate II, Form X

Grade 7 - November, 1969 - Advanced, Form Y

The analysis of the data was done both longitudinally and cross-sectionally. A detailed longitudinal analysis of each subtest was done on the scores of these subjects who participated in all subtests of all three test administrations. This procedure greatly reduced the number of subjects in each sample. But we shall show that the general results from the cross-sectional analysis are confirmed in the longitudinal analysis even with the reduction in the sample size. The sample of second grade, high SEL children was, unfortunately, small because of a failure on the part of the School System to administer the Fall, 1968, test in two of the schools from which the high SEL subjects were sampled. This did not affect the cross-sectional analysis but did attenuate the longitudinal analysis. We had attempted to

construct a questionnaire which was to have served the two purposes of providing indirect measures of SEL and of determining the Summer recess activities of each child. We had intended to correlate Summer activity with the change from Spring to Fall achievement scores. The time schedule of the project did not allow for a trial run on the questionnaire and, consequently, the questionnaire aspect of the project ended in total failure. This failure, fortunately, did not extend to the results from the achievement tests. They will be seen to be clear and interpretable.

All raw scores on the achievement tests were converted to grade-equivalent scores. The longitudinal analyses were done for each subtest and for composite means obtained by pooling the subtests into three categories: verbal, quantitative, and scientific. The sample sizes were somewhat larger for the analyses of composite means because means would be calculated when individual subtest scores were missing. The cross-sectional analyses were done for subtest scores and composite scores. In order to save space and avoid getting lost in a sea of numbers, only composite score results will be shown for the cross-sectional data.

Figure 1 shows the composite mean grade equivalence scores from all

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Insert Figure 1 about here
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subtests dealing with verbal abilities. The three test administrations for each grade level are on the abscissa, e.g., for the second grade the first test session was in the Fall, the second test was in the Spring, and the third test was in the following Fall (third grade). High SEL means are graphed with triangles and low SEL means with circles. Cross-sectional means are graphed with solid figures and longitudinal means with open

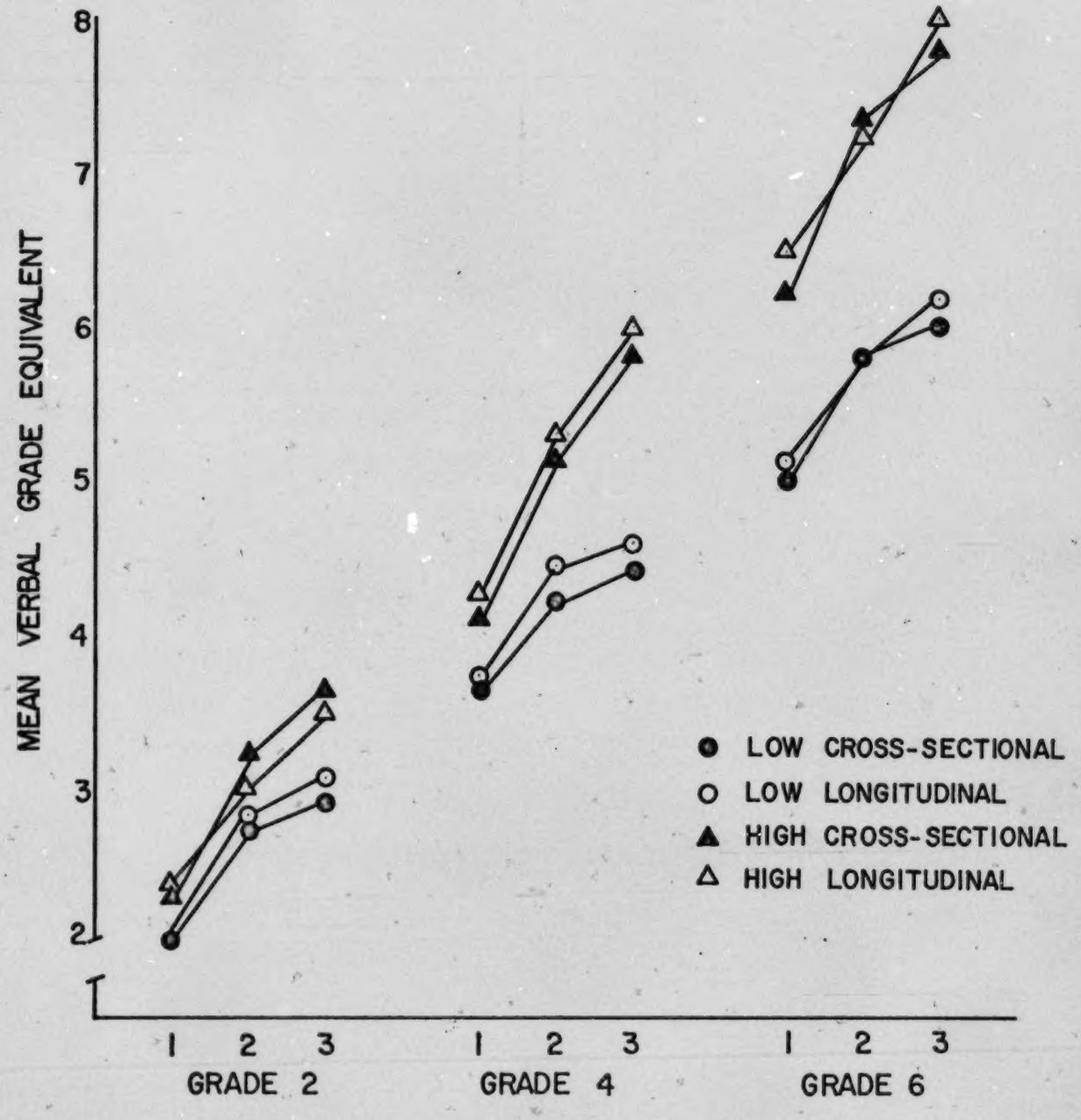
MEAN VERBAL GRADE EQUIVALENT
8
7
6
5
4
3
2
1 2 3
GRADE 2
1 2 3
GRADE 4
1 2 3
GRADE 6
LOW CROSS-SECTIONAL
LOW LONGITUDINAL
HIGH CROSS-SECTIONAL
HIGH LONGITUDINAL

Figure 1

figures. Figures 2 and 3 show the results for the quantitative and scientific abilities respectively. The first test for the second grade

- - - - - - - - - - - - - - - - - -
Insert Figures 2 and 3 about here
- - - - - - - - - - - - - - - - - -

did not have a science subtest. One later test included a combined science and social studies subtest. The combination is probably of dubious merit but it explains our use of that category.

Two results are clear from Figures 1 and 3. On the verbal and scientific subtests the high SEL children improve more than the low SEL children from Fall to Spring and from Spring to Fall. These two results hold for both the cross-sectional analysis and the longitudinal analysis. The high SEL children show more gain in grade equivalence from Fall to Spring. The amount of change tends to decrease from Spring to Fall, but the decrease in the gain is less pronounced for the high SEL children than for the low SEL children. Figure 2 shows that these effects are not obtained with the data from the quantitative subtests.

Table 1 shows the mean grade equivalence calculated for the three cate-

- - - - - - - - - - - - - - -
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gories of subtests using all the data, i.e., cross-sectionally. The absolute differences and percentage changes also are shown. In spite of the fact that the high SEL changes are all changes from higher initial levels, the amount and percentage change for the high SEL subjects is always greater than the corresponding changes for the low SEL subjects, on the verbal and scientific subtests.

The detailed longitudinal results are shown in Tables 2 through 7.

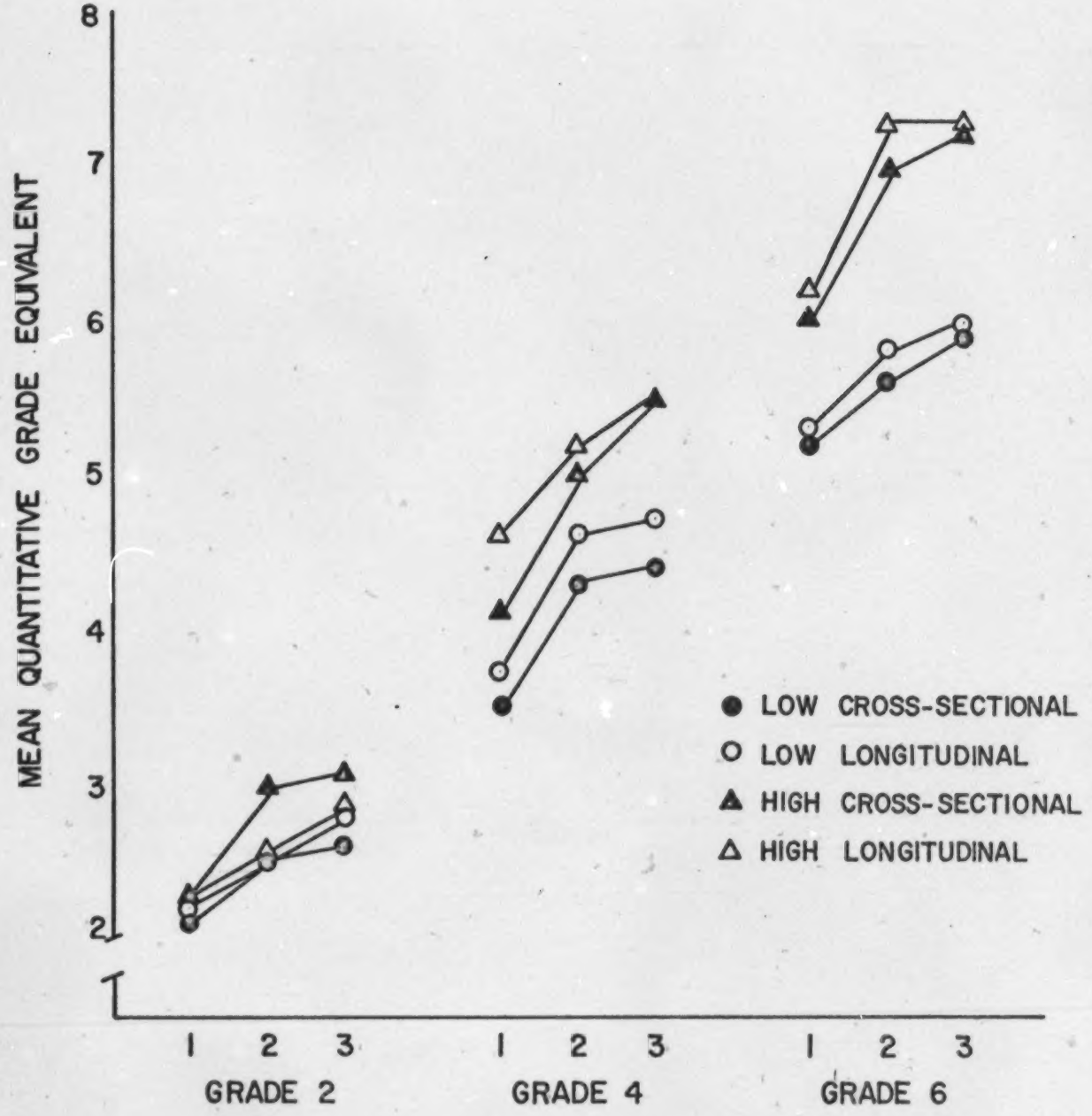
MEAN QUANTITATIVE GRADE EQUIVALENT
8
7
6
5
4
3
2
1 2 3
GRADE 2
1 2 3
GRADE 4
1 2 3
GRADE 6
LOW CROSS-SECTIONAL
LOW LONGITUDINAL
HIGH CROSS-SECTIONAL
HIGH LONGITUDINAL

Figure 2

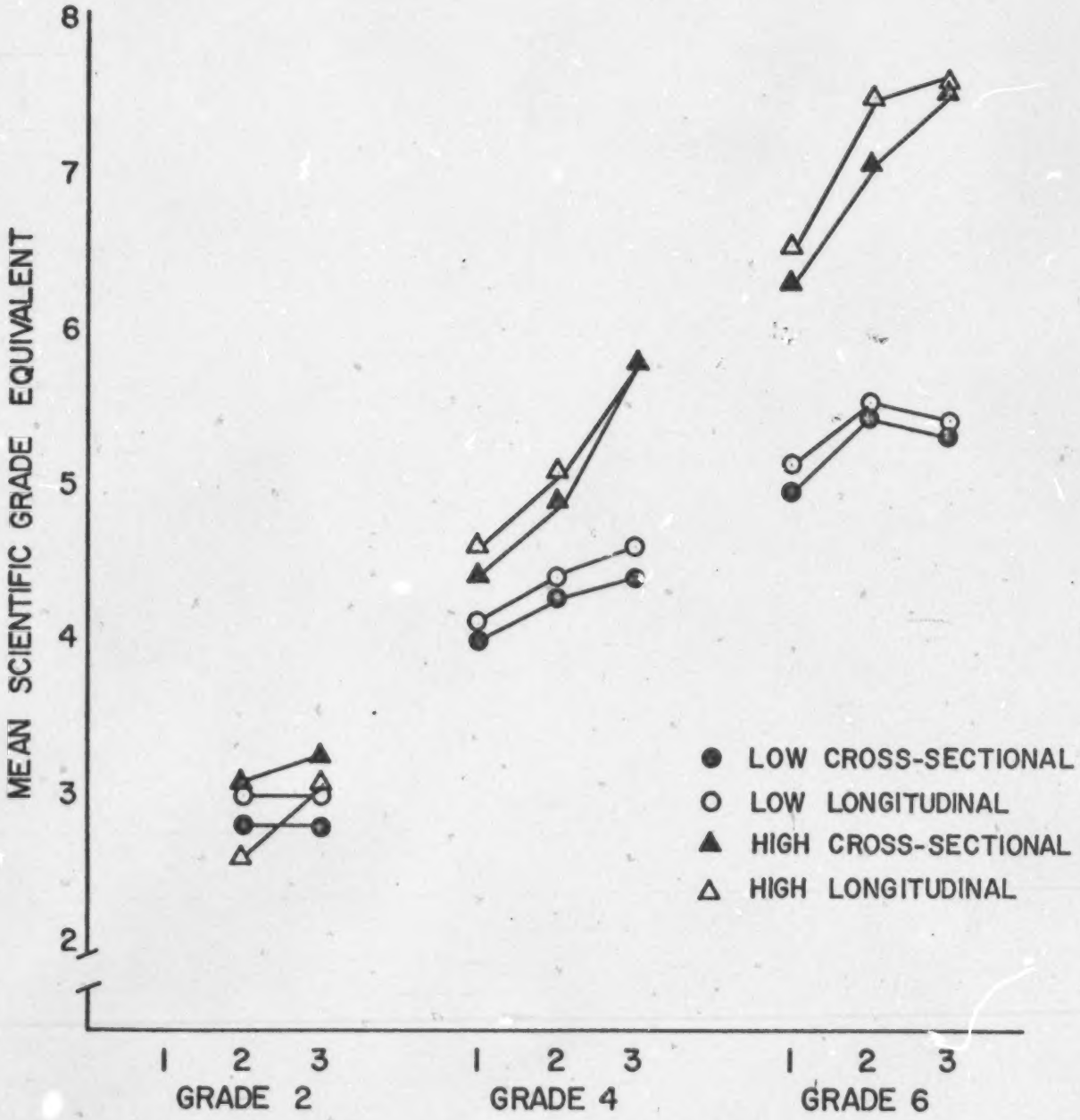
MEAN SCIENTIFIC GRADE EQUIVALENT
8
7
6
5
4
3
2
LOW CROSS-SECTIONAL
LOW LONGITUDINAL
HIGH CROSS-SECTIONAL
HIGH LONGITUDINAL
1 2 3
GRADE 2
1 2 3
GRADE 4
1 2 3
GRADE 6

Figure 3

Table 1

Mean Cross-Sectional Grade Equivalent For High SEL and Low SEL Children Beginning in Second, Fourth, and Sixth Grades for Fall, Spring, and Fall Tests of Verbal, Quantitative, and Scientific Categories (N = 4,224)

			Verbal			Quantitative			Scientific		
Low SEL											
GR	Test	N	Mean	Diff.	% Ch.	Mean	Diff.	% Ch.	Mean	Diff.	% Ch.
	1	202	2.009			2.060					
2	2	219	2.658	.649	32.3	2.485	.425	20.6	2.800		
	3	231	2.898	.240	9.0	2.631	.146	5.9	2.770	-.030	-1.1
	1	238	3.608			3.529			3.994		
4	2	246	4.209	.601	16.6	4.338	.809	22.9	4.254	.260	6.5
	3	230	4.425	.216	5.1	4.449	.111	2.5	4.405	.151	3.5
	1	263	4.988			5.157			4.965		
6	2	249	5.751	.763	15.2	5.645	.488	9.4	5.533	.568	11.4
	3	260	5.988	.237	4.1	5.898	.253	4.4	5.376	-.157	-2.8
High SEL											
	1	51	2.338			2.318					
2	2	264	3.199	.861	36.8	3.006	.688	29.7	3.059		
	3	253	3.625	.426	13.3	3.137	.131	4.4	3.314	.255	8.3
4	1	255	4.122			4.135			4.438		
	2	248	5.112	.990	24.0	5.011	.876	21.1	4.918	.480	10.8
	3	264	5.787	.675	13.2	5.496	.485	9.6	5.793	.875	17.7
	1	267	6.167			6.023			6.285		
6	2	275	7.289	1.122	18.1	7.010	.987	16.3	7.113	.828	13.1
	3	209	7.786	.497	6.8	7.219	.209	2.9	7.513	.400	5.6

- -

Insert Tables 2 through 7 about here

- -

The statistics for each grade level of each SEL are tabled for individual subtests. The number of decimal places has been reduced hopefully to increase the clarity. The first three columns show the mean grade equivalence for the three test administrations; the next three columns show the estimated standard deviations. The test-retest correlations (r) are shown for each possible pairing of the subtest scores. The last three columns show the matched-pair t-tests for each available test-retest pairing of a subtest. In general, a t-value is significant if the absolute value is greater than 2.00. Some of the specific t-values are particularly interesting; e.g., the fourth and sixth grade scores for arithmetic computation remain constant or actually dcreasee from Spring to Fall for both SELs. Similarly, some of the correlation coefficients are of specific interest; e.g., in the second grade the test-retest correlations for spelling are consistently lower than the other correlations, for both SELs.

Our results correspond to the results obtained by Grether and Hayes to the extent that the discrepancy between the performance of the high SEL children and the performance of the low SEL children continuously increases with grade level. However, the results differ even if allowance is made for differences in the timing of the test administrations. Our results show that 1) the high SEL children improve more than the low SEL children, from Fall to Spring, 2) although there is some tendency in both groups for the rate of improvement to "tail-off" from Spring to Fall, this "tailing-off" is much more pronounced for the low SEL children, and 3) the two previously stated results are clearly obtained on verbal and scientific subtests but are not clearly replicated on quantitative subtests. One could obviously speculate that some of the quantitative subtests measure abilities

Table 2

Longitudinal Means and Standard Deviations of Each Subtest on Each of Three Test Administrations for Low SEL Children First Tested in the Fall of Second Grade. Correlations (r) and Matched-Pair Significance (t) Are Shown for Each Repeated Measure.

Low SEL 2nd Grade N = 100	Mean			est. S.D.			r			t		
	1	2	3	1	2	3	1-2	1-3	2-3	1-2	1-3	2-3
Word Reading	1.9			.6								
Word Meaning		2.7	3.1		.9	1.0			.88			8.41
Para Meaning	2.0	2.8	3.1	.6	.8	1.0	.81	.79	.89	16.96	17.14	6.46
Vocabulary	2.2			1.0								
Spelling	2.0	3.0	3.0	.7	1.2	1.1	.41	.49	.56	8.98	10.28	0.00
Word Study Skills	2.3	3.0	3.1	1.2	1.1	1.1	.76	.69	.87	8.73	8.79	1.78
Language		3.3	3.6		1.7	1.9			.86			3.09
Arithmetic	2.2			.6								
Arith. Comp.		2.9	3.1		.9	.9			.81			3.60
Arith. Conc.		2.6	2.7		.5	.5		.67				2.46
Sci. & S.S.		2.8	3.0		.8	1.0			.83			3.58
N = 111												
Verbal	2.0	2.8	3.1	.8	1.0	1.1	.88	.80	.92	17.50	17.43	7.33
Quantitative	2.2	2.6	2.8	.6	.6	.7	.74	.75	.84	9.74	13.48	5.55
Scientific		3.0	3.0		1.1	1.0			.55			0.00

Table 3

Longitudinal Means and Standard Deviations of Each Subtest on Each of Three Test Administrations for Low SEL Children First Tested in the Fall of Fourth Grade. Correlations (r) and Matched-Pair Significance (t) Are Shown for Each Repeated Measure.

Low SEL 4th Grade N = 136	Mean			est. S.D.			r			t		
	1	2	3	1	2	3	1-2	1-3	2-3	1-2	1-3	2-3
Word Meaning	4.0	4.7	4.9	1.1	1.2	1.6	.76	.72	.83	10.18	9.44	2.59
Para Meaning	3.7	4.6	4.6	1.1	1.4	1.5	.69	.59	.73	10.27	8.53	0.00
Spelling	4.0	4.7	5.0	1.1	1.4	1.6	.82	.75	.85	10.17	10.97	4.15
Word Study Skills	3.6	4.2	4.3	1.5	1.7	1.8	.80	.65	.68	6.80	5.80	0.83
Language	3.5	4.4	4.8	1.3	1.6	1.9	.80	.73	.77	10.93	11.65	3.82
Arith. Comp	3.7	4.7	4.4	.5	1.2	1.0	.52	.54	.72	11.30	9.69	-4.15
Arith.Conc.	3.5	4.5	4.9	1.2	1.2	1.4	.72	.66	.78	12.99	15.01	5.28
Arith. Appl.	3.7	4.4	4.6	.9	1.1	1.6	.74	.66	.76	10.96	8.66	2.23
Social Studies	4.1	4.4	4.6	.8	1.0	1.3	.68	.72	.72	4.71	6.39	2.58
Science	4.1	4.4	4.6	1.0	1.2	1.3	.60	.61	.66	3.50	5.55	2.25
N = 148												
Verbal	3.8	4.4	4.7	1.0	1.4	1.5	.74	.73	.75	7.75	10.63	3.54
Quantitative	3.7	4.6	4.7	.8	1.1	1.2	.80	.72	.85	16.47	14.57	1.91
Scientific	4.1	4.4	4.6	.8	1.0	1.3	.64	.74	.61	4.65	6.84	2.32

Table 4

Longitudinal Means and Standard Deviations of Each Subtest on Each of Three Test Administrations for Low SEL Children First Tested in the Fall of Sixth Grade. Correlations (r) and Matched-Pair Significance (t) Are Shown for Each Repeated Measure.

Low SEL 6th Grade N = 150	Mean			est. S.D.			r			t		
	1	2	3	1	2	3	1-2	1-3	2-3	1-2	1-3	2-3
Word Meaning	5.1	6.1		1.3	1.8		.82			11.71	.	
Para Meaning	5.4	5.7	6.4	1.6	2.1	1.8	.78	.71	.77	2.79	9.36	6.34
Spelling	5.3	6.4	6.7	1.7	2.0	1.9	.86	.79	.82	13.20	14.51	3.13
Language	5.1	5.9	5.9	1.9	2.3	2.2	.86	.82	.87	8.33	7.76	0.00
Arith. Comp.	4.8	5.9	5.4	.9	1.6	1.1	.60	.46	.55	10.51	6.98	-4.52
Arith. Conc.	5.6	5.9	6.3	1.0	1.4	1.6	.66	.48	.57	3.48	6.03	3.49
Arith. Appl.	5.5	5.7	6.3	1.7	1.9	1.6	.78	.50	.56	2.03	5.93	4.42
Social Studies	5.1	5.7	5.6	1.4	1.7	1.7	.82	.63	.64	7.55	4.50	-0.85
Science	5.3	5.7	5.5	1.9	2.1	2.0	.72	.63	.72	3.25	1.46	-1.59
N = 161												
Verbal	5.1	5.8	6.2	1.5	2.0	1.9	.82	.80	.76	7.70	12.24	3.74
Quantitative	5.3	5.8	6.0	1.1	1.5	1.5	.81	.65	.75	7.15	7.75	2.39
Scientific	5.2	5.6	5.5	1.5	1.8	1.7	.85	.72	.76	5.35	3.14	-1.04

Table 5

Longitudinal Means and Standard Deviations of Each Subtest on Each of Three Test Administrations for High SEL Children First Tested in the Fall of Second Grade. Correlations (r) and Matched-Pair Significance (t) Are Shown for Each Repeated Measure.

High SEL 2nd Grade N = 34	Mean			est. S.D.			r			t		
	1	2	3	1	2	3	1-2	1-3	2-3	1-2	1-3	2-3
Word Reading	2.2			.7								
Word Meaning		2.9	3.3		.8	1.0			.81			3.98
Para Meaning	2.3	3.0	3.4	.8	.8	1.1	.83	.79	.87	8.75	9.46	4.13
Vocabulary	2.3			.9								
Spelling	2.3	2.6	3.1	.6	.8	1.0	.02	.60	.31	1.73	5.83	2.73
Word Study Skills	2.6	3.1	3.4	1.3	.9	1.0	.79	.71	.85	3.61	5.08	3.31
Language		3.2	3.6		1.6	1.8			.87			2.63
Arithmetic	2.3			.6								
Arith. Comp.		3.0	3.4		1.0	1.1			.76			3.18
Arith. Conc.		2.4	2.5		.5	.5			.71			1.53
Sci. & S.S.		2.8	3.2		.8	1.1			.86			4.02
N = 41												
Verbal	2.4	3.0	3.5	.7	.9	1.1	.86	.83	.80	8.25	10.85	4.85
Quantitative	2.3	2.6	2.9	.6	.6	.8	.79	.73	.81	4.94	7.02	4.02
Scientific		2.6	3.1		.8	.9			.36			3.32

Table 6

Longitudinal Means and Standard Deviations of Each Subtest on Each of Three Test Administrations for High SEL Children First Tested in the Fall of Fourth Grade. Correlations (r) and Matched-Pair Significance (t) Are Shown for Each Repeated Measure

High SEL 4th Grade N = 159	Mean			est. S.D.			r			t		
	1	2	3	1	2	3	1-2	1-3	2-3	1-2	1-3	2-3
Word Meaning	4.4	5.6	6.3	1.1	1.4	1.6	.74	.75	.80	16.03	22.54	9.12
Para Meaning	4.4	5.5	6.1	1.3	1.4	1.8	.67	.64	.74	12.60	15.41	6.24
Spelling	4.4	5.3	5.7	1.2	1.4	1.6	.74	.77	.82	11.87	16.05	5.48
Word Study Skills	4.1	5.0	5.6	1.6	1.8	1.8	.79	.73	.82	10.15	14.98	7.01
Language	4.4	5.5	6.5	1.5	1.8	2.2	.80	.74	.79	12.82	17.83	9.34
Arith. Comp.	4.0	4.9	4.9	.5	.9	1.0	.60	.49	.58	15.74	13.02	0.00
Arith. Conc.	4.7	5.7	6.1	1.3	1.4	1.3	.71	.76	.67	12.22	19.60	4.58
Arith. Appl.	4.4	5.2	5.8	1.0	1.4	1.7	.74	.70	.72	10.70	14.37	6.34
Social Studies	4.6	5.1	5.9	1.1	1.3	1.7	.75	.76	.80	7.26	14.62	9.87
Science	4.6	5.2	5.9	1.2	1.6	1.7	.73	.66	.79	6.92	12.81	8.22
N = 167												
Verbal	4.3	5.3	6.0	1.2	1.4	1.6	.84	.85	.88	17.00	25.61	11.90
Quantitative	4.6	5.2	5.5	.9	1.1	1.2	.80	.80	.78	11.74	16.10	5.04
Scientific	4.6	5.1	5.8	1.0	1.4	1.6	.84	.79	.86	8.29	15.27	11.07

Table 7

Longitudinal Means and Standard Deviations of Each Subtest on Each of Three Test Administrations for High SEL Children First Tested in the Fall of Sixth Grade. Correlations (r) and Matched-Pair Significance (t) Are Shown for Each Repeated Measure

High SEL 6th Grade N = 158	Mean			est. S.D.			r			t		
	1	2	3	1	2	3	1-2	1-3	2-3	1-2	1-3	2-3
Word Meaning	6.1	7.5		1.4	1.7		.81			17.65		
Para Meaning	6.5	7.7	8.0	1.7	2.1	2.1	.82	.77	.83	12.55	14.04	3.08
Spelling	6.5	7.7	8.0	1.8	2.1	2.1	.88	.83	.86	15.10	16.08	3.39
Language	6.8	7.9	8.0	2.1	2.2	2.2	.87	.81	.88	12.56	11.35	1.17
Arith. Comp.	5.6	7.4	6.8	1.0	1.8	1.6	.65	.65	.73	16.41	12.40	-5.97
Arith. Conc.	6.3	7.3	7.7	1.2	1.8	1.9	.84	.72	.73	12.26	13.24	3.69
Arith. Appl.	6.7	7.1	7.4	2.0	2.1	1.7	.84	.62	.61	4.32	5.38	2.20
Social Studies	6.2	7.2	7.5	1.6	2.0	2.2	.80	.77	.82	10.47	11.62	2.96
Science	6.9	7.9	7.6	2.1	2.1	2.2	.74	.76	.78	8.30	5.90	-2.64
N = 176												
Verbal	6.5	7.6	8.0	1.5	1.8	1.9	.89	.86	.85	17.64	20.33	5.21
Qauntitative	6.2	7.3	7.3	1.2	1.7	1.4	.89	.84	.82	17.46	9.20	0.00
Scientific	6.5	7.5	7.6	1.7	2.0	2.1	.80	.82	.85	11.02	12.14	1.18

that are practiced daily by everyone or by no one. Either hypothesis would predict the relatively more similar scores for the two SELs on the quantitative subtests than on the verbal and scientific subtests.

In spite of the apparent inconsistencies, a comparison of our results with those of Grether and Hayes yields one very convincing consistent result, the difference between high and low SEL rates of change from Spring to Fall. This difference in high and low SEL rate of change from Spring to Fall has also been obtained from intelligence quotient (I.Q.) measures (Coffey and Wellman, 1936-7; Wellman, 1940).

The previous results and now our own results all clearly point to the same recommendation--Summer School.

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